MECHANICAL ENGINEERING

September 1961

SPECIAL REPORT

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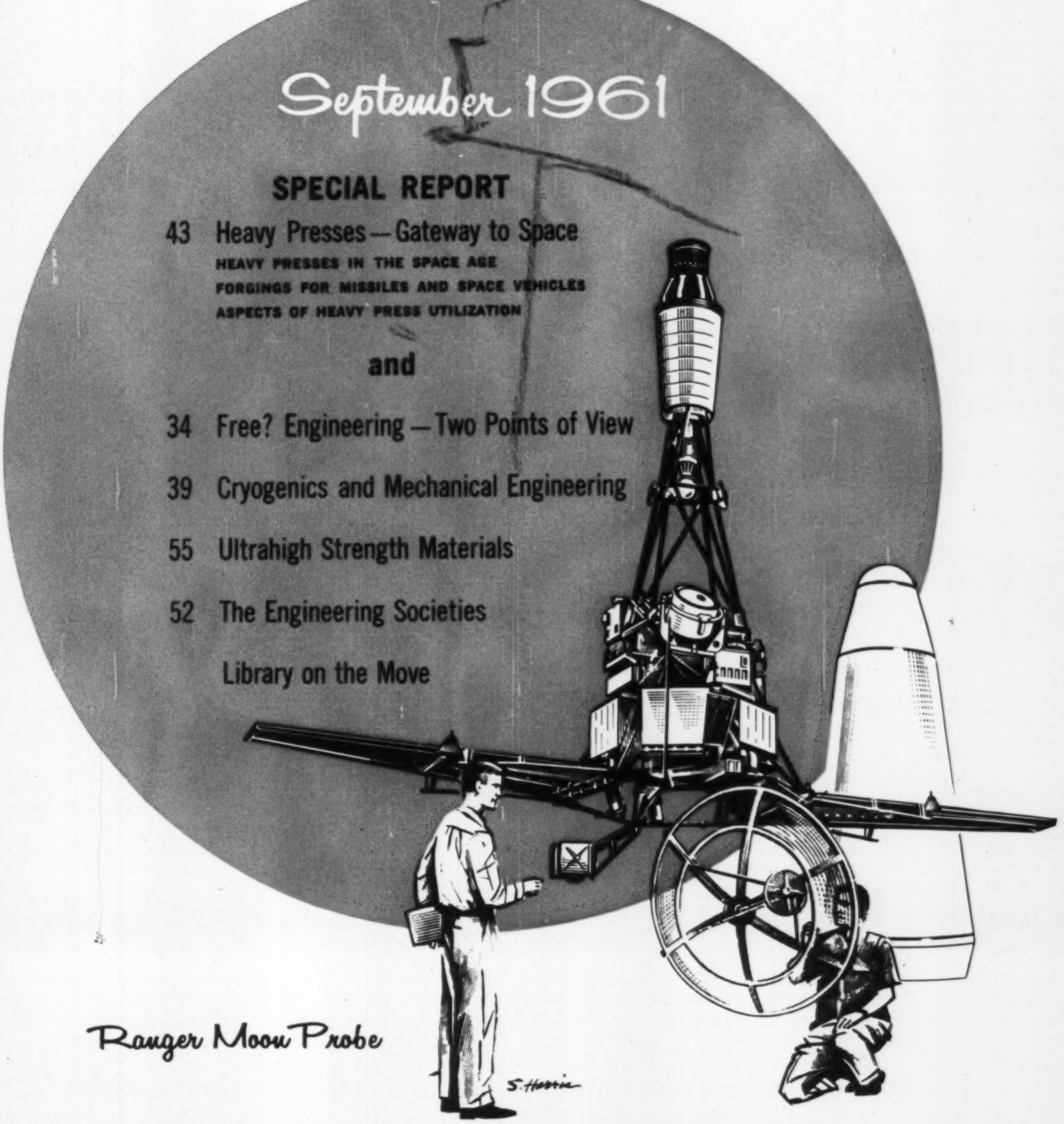
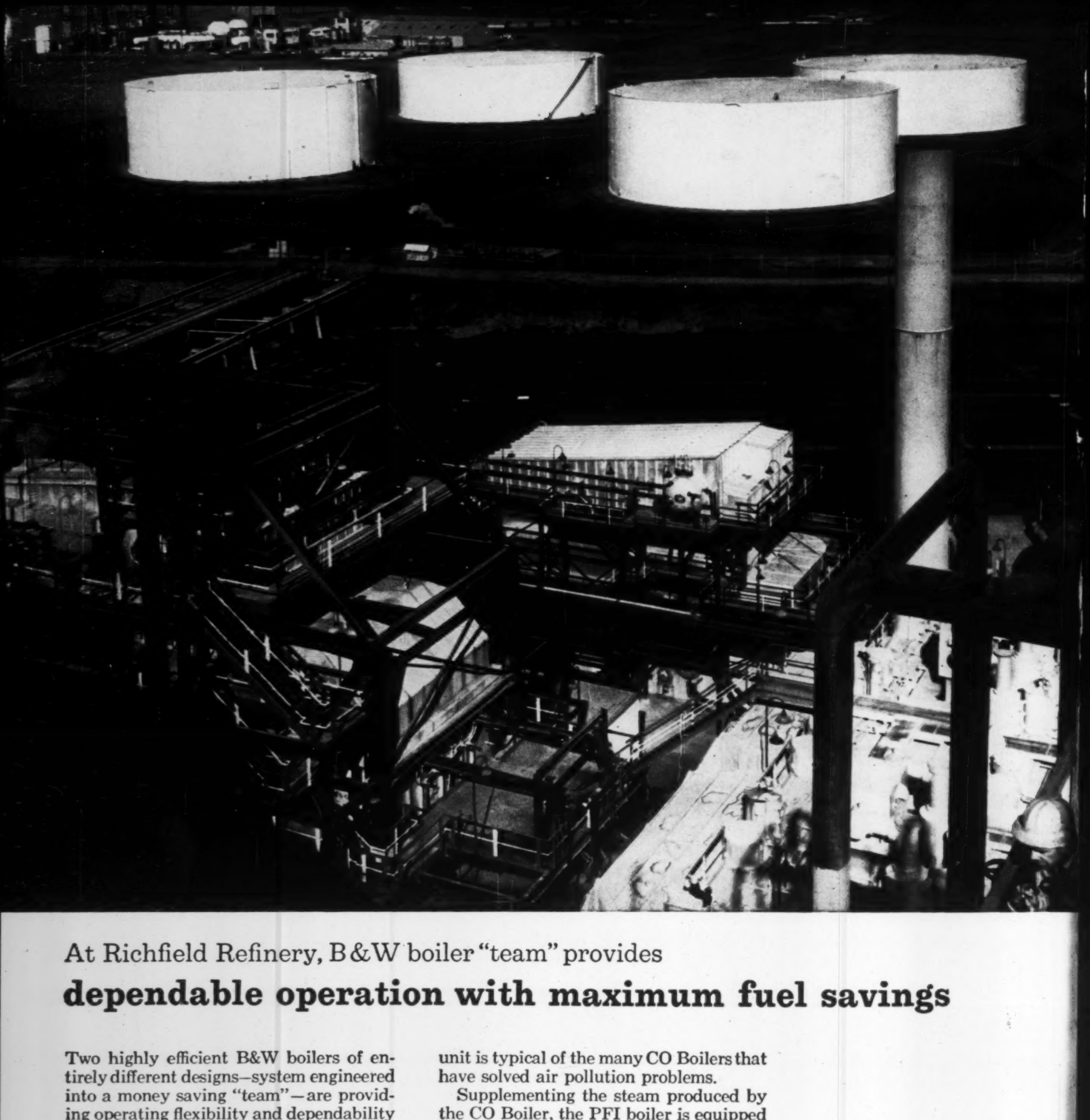


Ranger Moon Probe



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THE COVER

This is the Ranger I spacecraft at the California Institute of Technology Jet Propulsion Laboratory. At the bottom of the 675-lb craft can be seen the parabolic directional antenna. On each side, the winglike solar panels in operative position. At the right and to the rear is the white shroud which protects the spacecraft from aerodynamic heating during its ride through the atmosphere atop the Atlas-Agena B system. For the story on the moon probe, see "Briefing the Record," pages 60–61.

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"Free" engineering originates in sales promotion—offering more than the competition. Should it be approved, or condemned? Here are both sides of this awkward coin, the professional dilemma.

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Below −250 F, the area of cryogenics, common gases become liquid. Industry takes advantage of the different boiling points of liquefied gases to separate them—obtaining liquid oxygen, for example.

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Conceived in the 1940's, the heavy-press development made possible efficient distribution of metal for high-speed aircraft. Now it's essential in the production of integral components for missiles.

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As engineering grows in depth and complexity, so does engineering literature. So does the need for reference to this storehouse of knowledge. ESL's new facilities mean greater service to you.

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The advent of steel revolutionized industry. Today we are looking right into an era of materials with ten times the strength of steel. All machine design will move to a higher level of sophistication.

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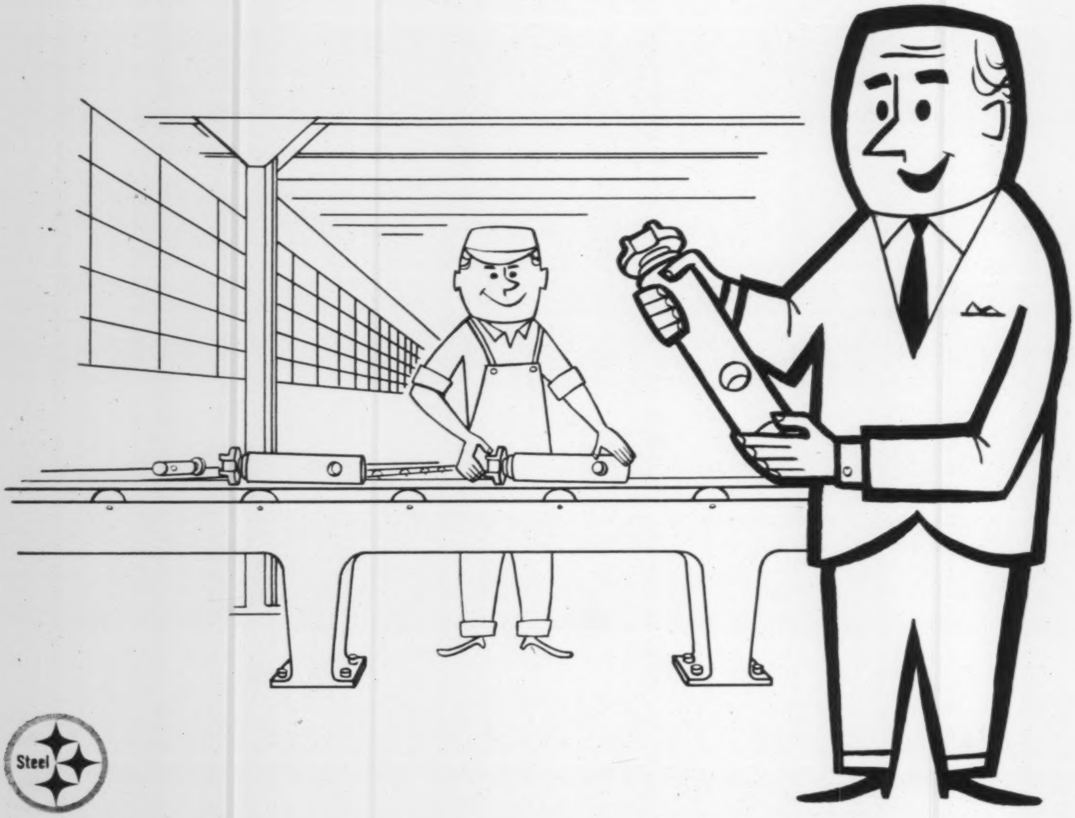

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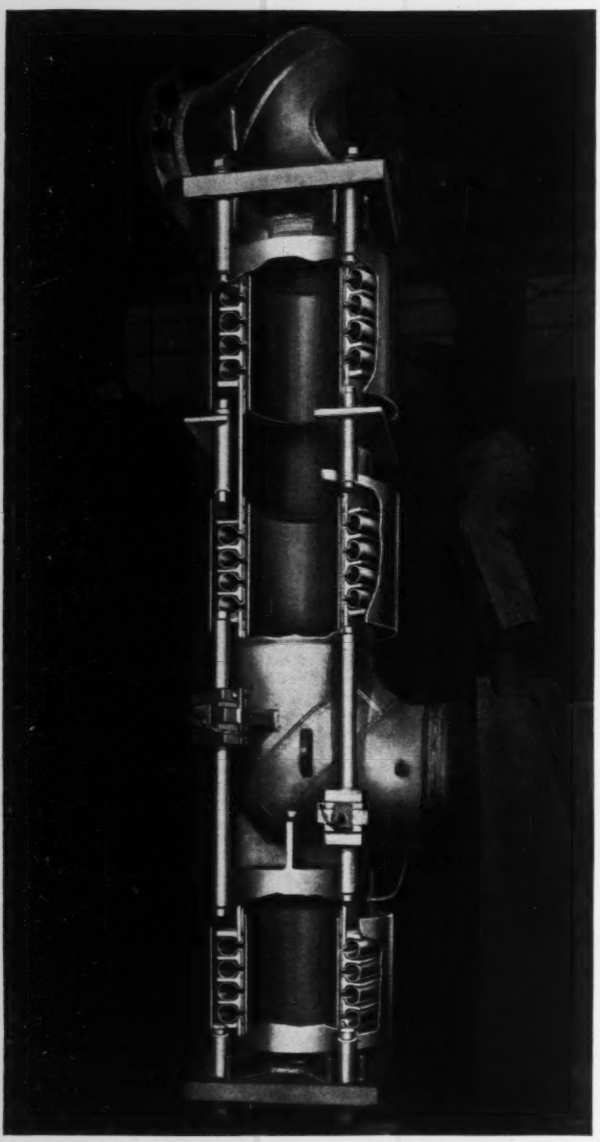
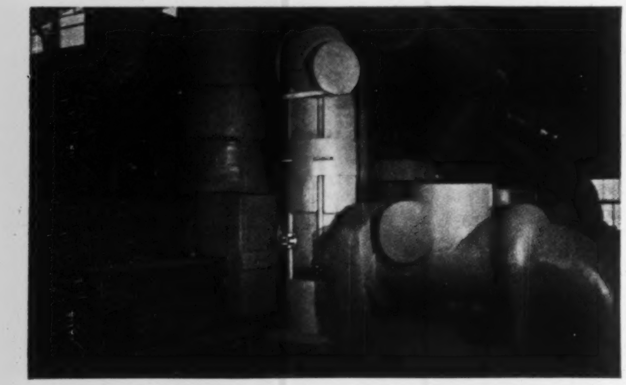


One of four Zallea-developed toroidal, pressure-balanced expansion joints at Philadelphia Electric's Eddystone station. Anchored at reheat stop valve, expansion joint absorbs movement at flow end bellows (top). Expansion joints are 20" I.D., operate at 290 psi, were tested at 580 psig. The unit is cut-away to show internal construction.



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by
James M. Jenks

In a sense, this is the golden age for engineers. Once buried in corporate obscurity, many of them have emerged today as likely heirs apparent to the big jobs — and the big rewards — of business and industry. One impressive indication of this growth is that money spent in research and development over the past fifteen years has increased six-fold.

Despite this stepped-up activity, however, the once disorganized scramble for engineers seems to have ended . . . at least temporarily. And perhaps it's a good thing. Actually, the more perceptive engineers had always realized that unusually high starting salaries were often illusory. The gap between money being offered beginners and the incomes of experienced men was narrowing rapidly. Further, more and more thinking technical men concluded that even top engineering salaries are low when compared with the remuneration of highly placed general executives.

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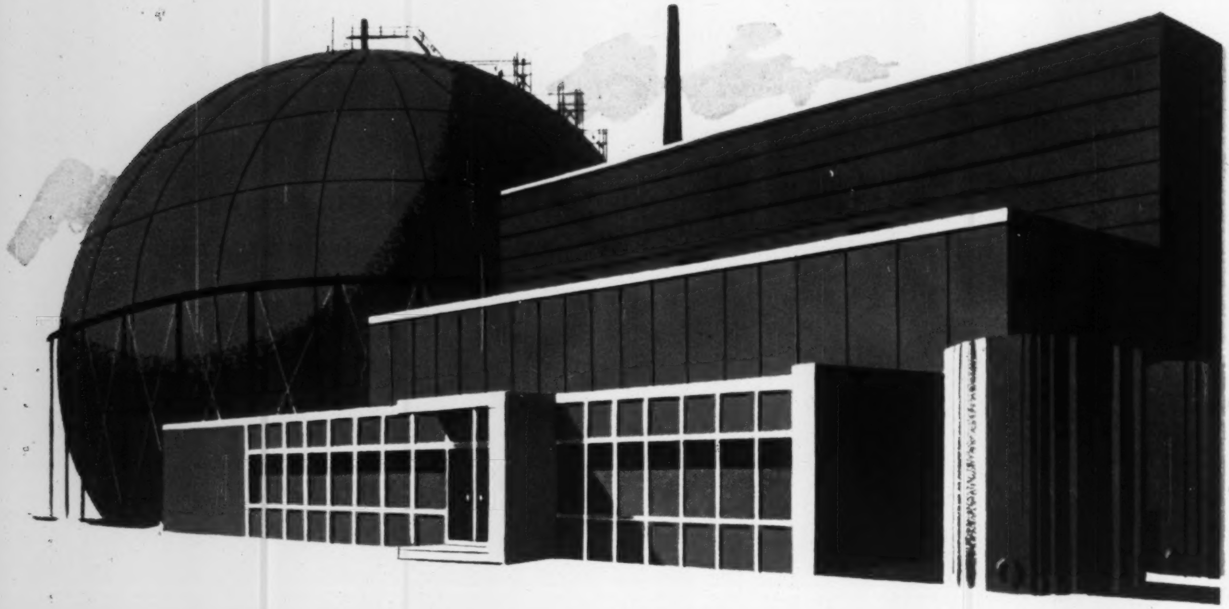

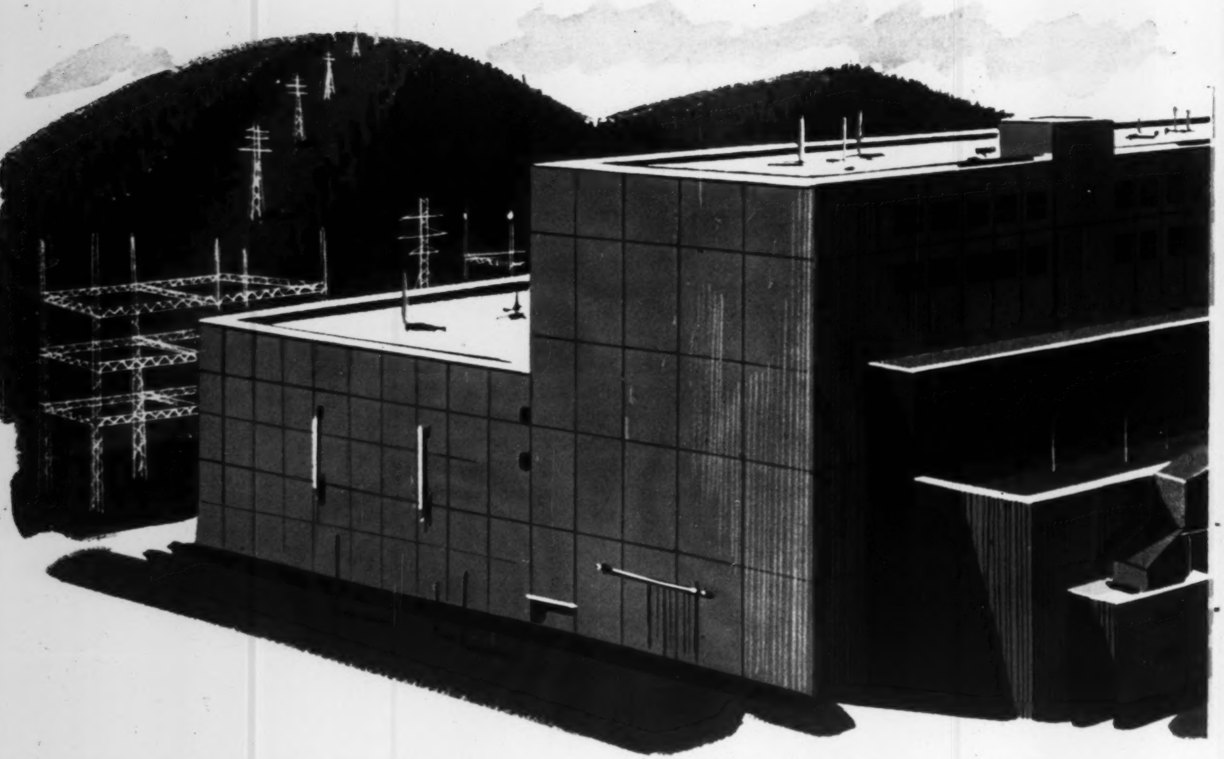

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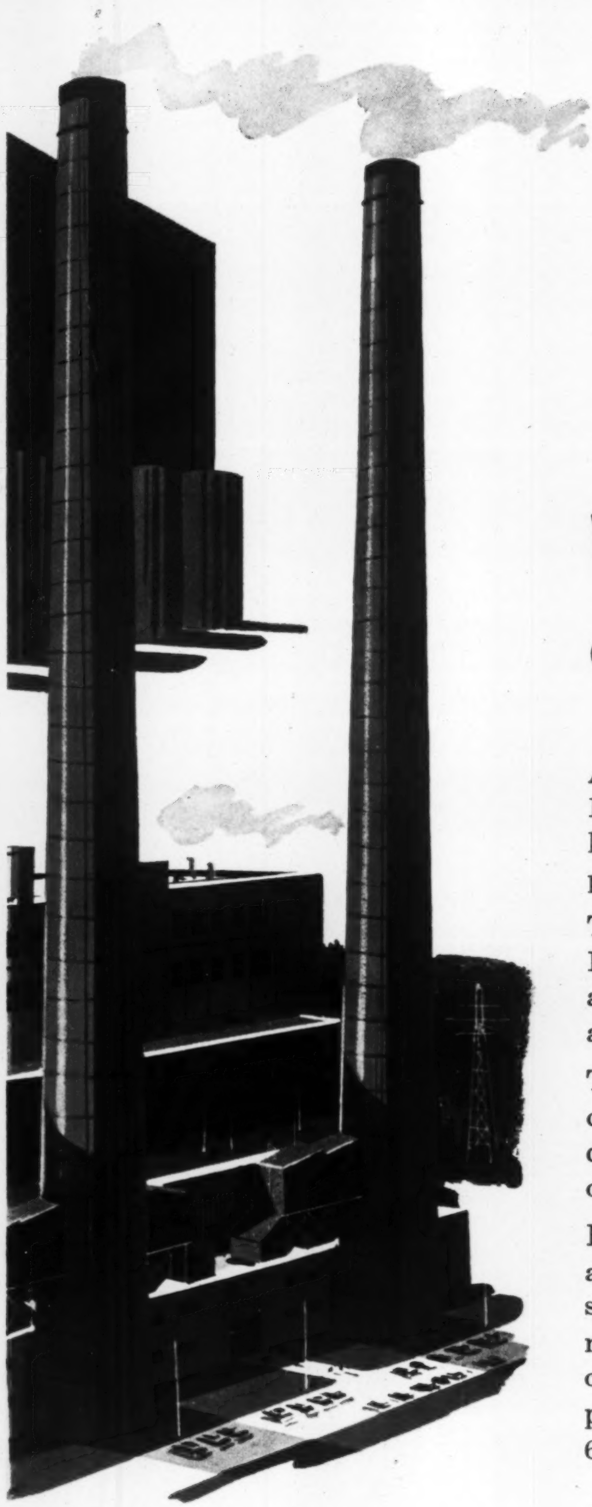

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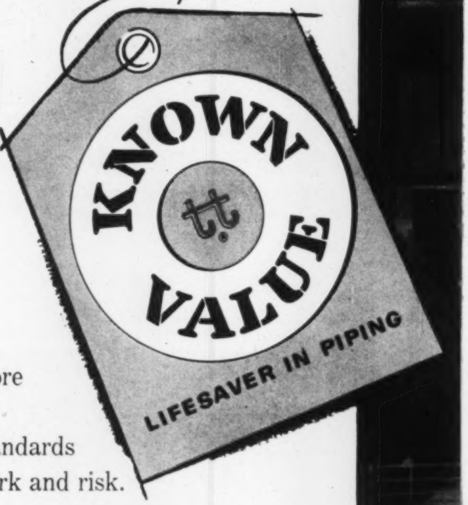

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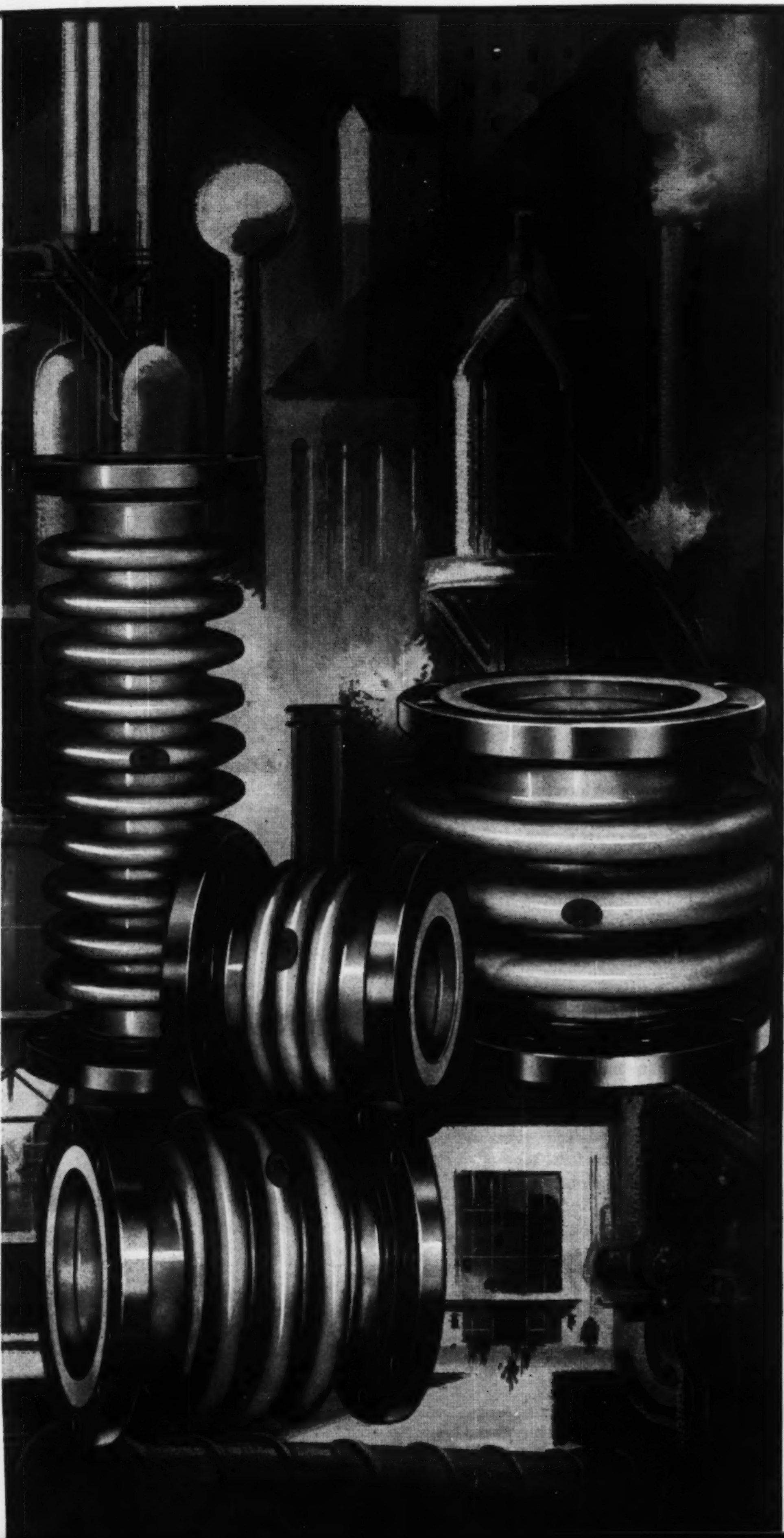

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With the acquisition of the Thomas Flexible Disc Coupling line, Koppers now provides engineering solutions to a wide range of industrial coupling problems. Need a lubricated gear-type coupling for transmitting high loads? Koppers world-famous Fast's coupling line does the job on shafts up to 32 inches. Need a maintenance-free flexible-disc coupling with no backlash? The highly engineered Thomas line holds the answer—with miniature couplings as small as 1/12th of an ounce. Need a coupling to absorb impact or vibration? The Holset line of resilient, non-lubricated couplings protects equipment in most diesel, compressor and shock load applications.

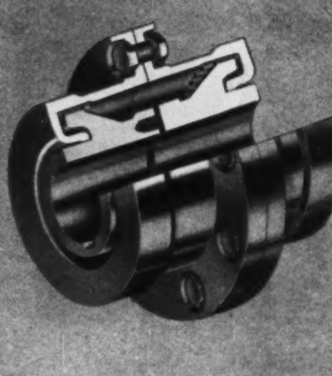
Because each of these coupling lines has its particular application in industry . . . and because each is a recognized name in the power transmission field . . . you can continue to buy them by brand—just as you have in the past. Of considerable importance are the experienced, extensive engineering and manufacturing services of the entire Koppers organization that are available to help you with your power transmission problems . . . in any size, in any quantity, for any use.

KOPPERS COMPANY, INC.
COUPLING DEPARTMENT
Baltimore, Md. • Warren, Pa.
Engineered Products Sold with Service

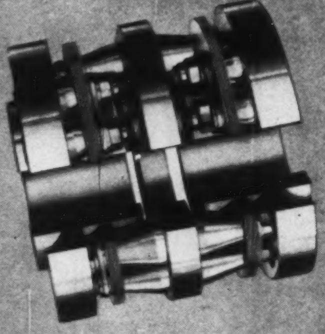
COUPLING A BILLION HORSEPOWER

Circle No. 81 on Readers' Service Card

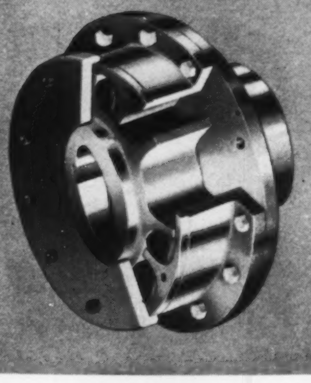
FAST'S



THOMAS ®



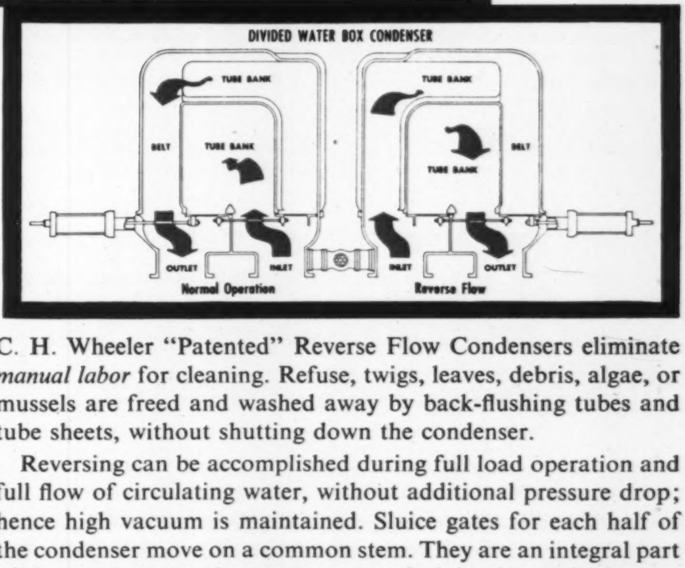
HOLSET ®



REVERSE FLOW "SELF-CLEANING"

ELIMINATES CONDENSER DOWN TIME

AND CUTS YOUR MAINTENANCE COSTS



C. H. Wheeler "Patented" Reverse Flow Condensers eliminate *manual labor* for cleaning. Refuse, twigs, leaves, debris, algae, or mussels are freed and washed away by back-flushing tubes and tube sheets, without shutting down the condenser.

Reversing can be accomplished during full load operation and full flow of circulating water, without additional pressure drop; hence high vacuum is maintained. Sluice gates for each half of the condenser move on a common stem. They are an integral part of the condenser and no extra external piping is required.

Each half of the condenser can be back-flushed independently or both halves can be flushed simultaneously, with either one or two circulating pumps operating.

For complete Reverse Flow "Self-Cleaning" story— write for catalog W-503. To know how Reverse Flow "Self-Cleaning" can cut YOUR condenser down time costs—call your C. H. Wheeler representative.

Affiliated sources for steam condensers,
heat exchangers, pumps,
nuclear steam generators and related
components, sea water distillation plants,
marine auxiliary equipment.

C. H. WHEELER / **GRISCOM-RUSSELL**
Philadelphia 32, Pa. — Massillon, Ohio
Circle No. 135 on Readers' Service Card

Tomorrow's weather report will be clear and dependable

THANKS TO WEATHER SATELLITES SUPPLIED WITH AUXILIARY POWER BY COMPACT NUCLEAR REACTORS, meteorologists will be able to make far more accurate forecasts in the not too distant future. By orbiting advanced weather satellites for extended periods of time, forecasters could secure a steady stream of information about changes in the upper atmosphere of the earth. To give these satellites, and other space vehicles, long periods of usefulness, Atomics International is today developing compact nuclear reactors which will provide a lightweight, reliable source of electricity for as long as a year, yet will never need maintenance. At Atomics International there are many other equally challenging nuclear projects underway. *You* are invited to share in this important work.

Immediate opportunities are available in:

STRESS ANALYSIS. Degree plus five or more years of experience either in thermal stress or dynamic stress resulting from shock and vibration loads in aircraft structures. Responsibilities will entail design support for compact nuclear power plants for space applications, including review of all designs with respect to stresses resulting from thermo gradients and transients, static loadings, vibrational and shock loadings.

CORE ANALYSIS. Core analysis of compact reactors including both core statics (criticality, reactivity coefficients, control statics) and stability analysis (core transients, amplitude response, interpretation of oscillator and noise measurements).

SHIELDING ANALYSIS. Analysis of thin shield systems using high speed computers. Proposal of experiments to substantiate calculations and analysis of test results. Degree and three to five years experience required including an understanding of Monte Carlo methods.

THERMOELECTRIC. Electrical engineer with one or more years experience in the development of thermoelectric equipment to originate and develop advanced, light weight thermoelectric equipment for use with compact nuclear power plants for space and other mobile applications.

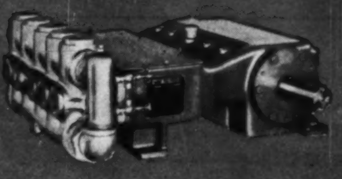
HEAT TRANSFER. Senior engineer to be responsible for system engineering studies on the thermal, hydraulic and thermodynamic performance of compact power reactor systems.

For specific details write: Mr. J. Newton,
Personnel Office, Atomics International,
8900 DeSoto Avenue, Canoga Park, Calif.

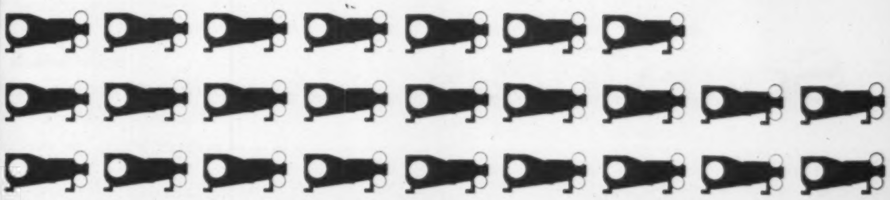
All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

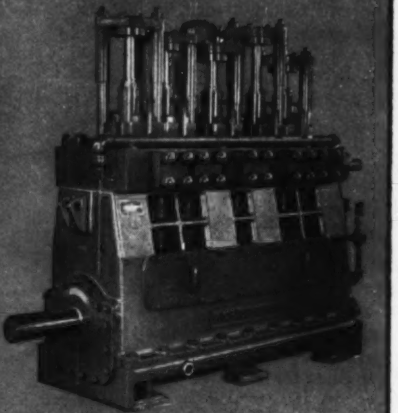
ATOMICS INTERNATIONAL
Division of North American Aviation

Circle No. 97 on Readers' Service Card

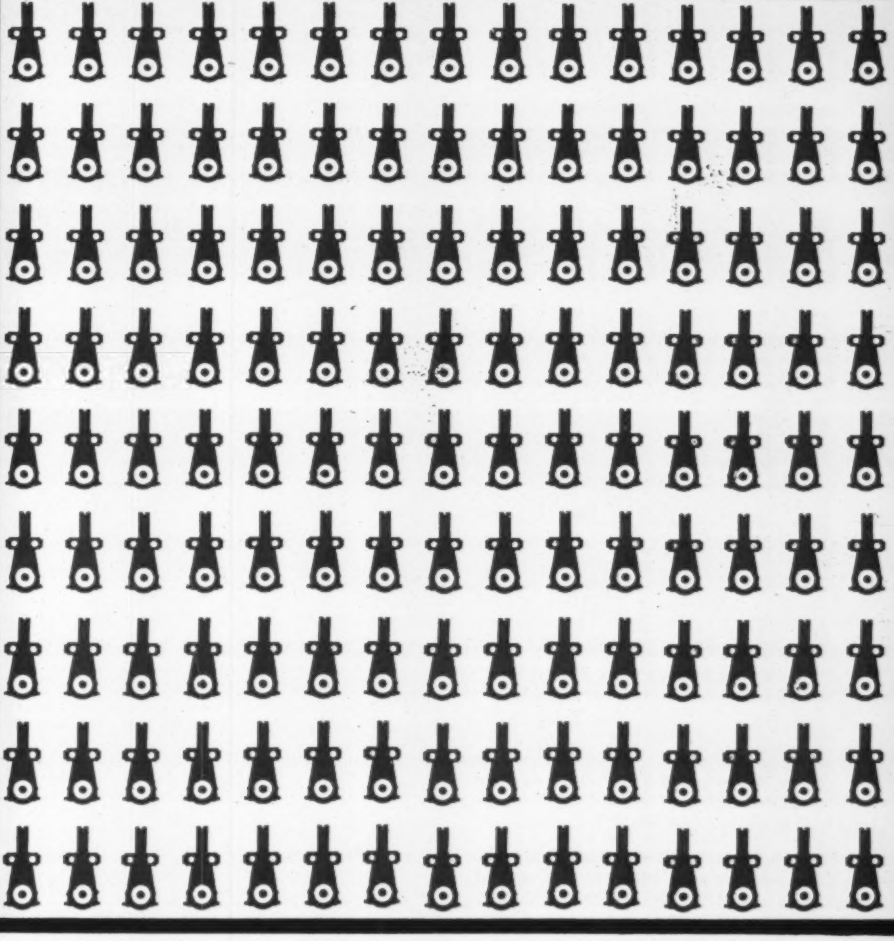


HORIZONTAL PLUNGER PUMP
25 sizes—15 to 160 HP





VERTICAL PLUNGER PUMP
135 sizes—20 to 900 HP



Choose a Worthington plunger pump . . .

ODDS FAVOR YOU–160:1

Yes, you can choose from 160 standard sizes in the basic Worthington plunger pump line—25 horizontals, 135 verticals. You get 160 chances to be right from our basic pump models. But that isn't all.

In both lines, speeds can be varied, still other plunger and cylinder sizes are available. So each type can be tailored to deliver a very exact performance.

Remember, you choose from two basic types—horizontal or vertical. Each has its basic benefit. The horizontal power pumps have extremely low first cost; the vertical power pumps are designed for extremely rugged, long-life service.

Both vertical and horizontal Worthington power pumps are engineered to give the most reliable possible performance for their type. Stainless steel valves and Colmonoy plungers are typical long-life features.

You'll find both Worthington power pump types are designed for easy maintenance. There is fast access to valves through individual valve covers—piping remains undisturbed. Each cylinder size will accept a choice of plunger diameters to suit service conditions, and other parts are interchangeable between similar models.

Yes, because of the breadth and flexibility of the line, Worthington power pumps can be matched quickly to any power pump installation.

For information, write Worthington Corporation, Dept. 32-12, Harrison, New Jersey. In Canada, Worthington (Canada) Ltd., Brantford, Ontario.

Circle No. 141 on Readers' Service Card

WORTHINGTON

PRODUCTS THAT WORK FOR YOUR PROFIT

Some Ideas

for your file of practical information on
drafting and reproduction

KEUFFEL & ESSER CO.

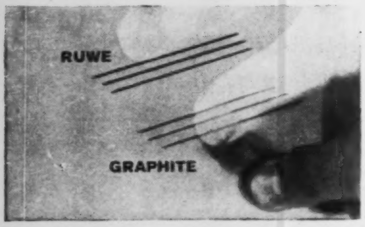
The stone tablet and chisel were pretty widely used writing and drawing instruments in their day.

But they don't command much of a following any longer. Like so many tools of the past, they gave way to better methods of portraying information. Some of these methods occurred by accident, some were developed by experts to serve specialized needs. Three good examples of the latter are described here.

A Couple of "Better" Pencils

When polyester drafting film first came into use, it was found that standard graphite pencils with clay binders, while fine for paper, smudged too readily on film.

So a new kind of pencil was needed—and developed. It was called the Duralar. With both binder and color agent made entirely of plastic, Duralar deposited a black, dense line on film, which could neither be smudged nor washed away.



But since washability is not the touchstone of every drafting operation, K&E went a step further. Result – the Ruwe pencil. Having all the "fine feel" and erasibility of graphite, on both film and cloth, the Ruwe deposits a blacker, denser line than graphite, with the smudge resistance the old graphite pencil could not provide.

Here's why: the Ruwe pencil *is* graphite, but with a plastic binder instead of clay. Color coded in five degrees of hardness from 2S to 6S, Ruwe is available in wood pencils and leads. More good news is that Ruwe is now available in 2S and 3S hardnesses for fine-line automatic pencils as well. The lead is just .036" in thickness – ideal for free-hand lettering.

It's interesting to note, that since the introduction of Ruwe, other plastic-graphite pencils have been placed on the market. If you're interested in testing the original we'll send free Ruwe pencils to you – just send the coupon.

Now You See 'em...Now You Don't

For engineering drawings, or freehand sketches, K&E GUIDE LINE$^{T.M.}$ tracing papers, cloths and films make light work for you – by making light *work* for you. The light blue cross-section lines are visible to the eye, but will not reproduce on your diazos or blueprints. Other companies make similar products but here's the important K&E contribution: GUIDE LINE is now available in the widest variety of drafting media ever. Specifically: ALBANENE® and CRYSTALENE® 100% rag stock tracing papers, PHOENIX® water-resistant tracing cloth and HERCULENE® polyester base drafting film. So whichever sheet you use, odds are it's available in GUIDE LINE first.

We especially recommend GUIDE LINE products for accurately guiding freehand work such as plant layouts, organization charts, electrical diagrams, etc. Your freehand work actually will look more like a finished detail than a sketch. And confidential notes will drop out too, if written or typed in special colors.

Available in a wide variety of grid sizes, GUIDE LINE comes in rolls or pads on ALBANENE and CRYSTALENE, in rolls on PHOENIX and HERCULENE, and can be supplied with your own title block or special heading.

Send for some free samples and the GUIDE LINE brochure.

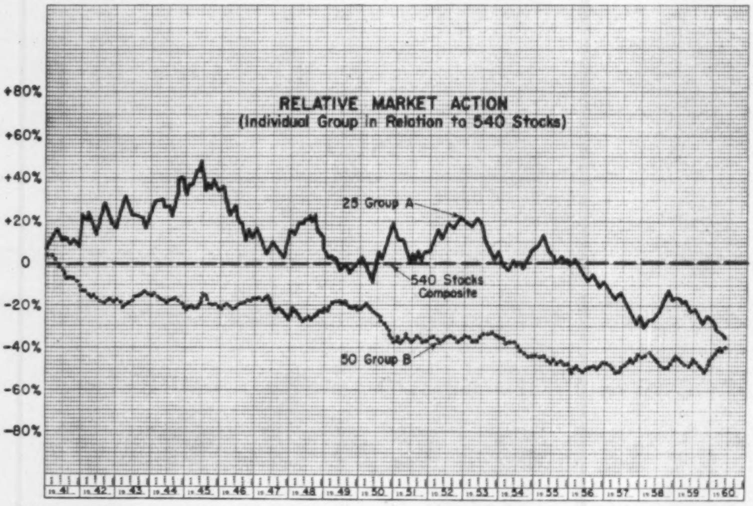
Through The Looking Glass

No more "Alice in Wonderland" wandering about when you want to locate the graph sheet you need for a specific job. Reason – K&E graph sheets now are packaged with a new "looking glass" – A time-saving *visual* package. This unique package has a window in the front so you can see the sheet inside. This is a boon, especially if you use a wide variety of graph sheets. Apart from the packaging, we've done a few other things to make graph-sheet selection easy and infallible.

Every user of graph paper puts it to a different task. So we have put together a complete line of graph papers, one or more of which will almost certainly meet your particular requirements. As a matter of fact, odds are 1000 to 1 that we already make and sell the sheet you require. In the event that we don't, we'll work with you to create it.

And we bend over backwards to make sure every sheet with the K&E symbol more than does its job. To insure accuracy of performance, every K&E graph sheet ever made was printed from precision-engraved plates by the letterpress process. The paper used – translucent or opaque – has at *least* 50% rag content – 100% in some cases. And before any of it ever gets to the printer, it undergoes extensive examination in our quality control labs.

There is a lot more we could tell you about K&E graph sheets. We have prepared a selection guide for your use. If you'd like to have one, it's free, along with some sample sheets in the new *visual* package.



12,300 variables at a glance. Here's a typical stock market chart used to study relative market action. Center line is market behavior of 540 stocks over 20-year period. Two basic stock groups of 25 and 50 individual stocks, averaged, are plotted against market (figured at zero per cent). Resultant chart shows all-important slope of curve which – far more than gross increases – tells the story of the stocks' vitality. No list of statistics, no matter how exhaustive, could give the relative interactions shown here. This picture is possible only with a graph.

KEUFFEL & ESSER CO., Dept. ME-9, Hoboken, N. J.

Please send me free:

☐ Ruwe Pencils ☐ GUIDE LINE$^{T.M.}$ Brochure and Samples
☐ Graph-paper Selection Guide and Samples

Name & Title________________________

Company & Address________________________

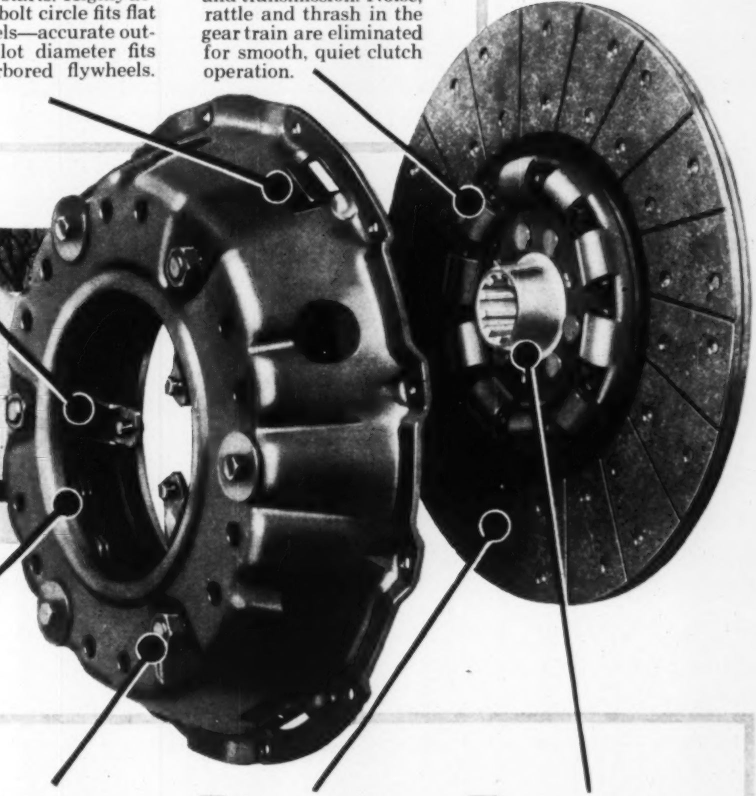
________________________ 4234

Circle No. 79 on Readers' Service Card

1 HIGH-SPEED OPERATION
Balanced release levers permit high-speed drives. Lever "throwout" is eliminated for longer bearing life. Patented anti-friction rollers give instant release with minimum pedal pressure.

2 ACCURATE FIT
Close-tolerance drive between cover and pressure plate assures smooth starts. Highly accurate bolt circle fits flat flywheels—accurate outside pilot diameter fits counterbored flywheels.

3 VIBRATION DAMPENER
Coil-spring vibration dampener absorbs vibrations between engine and transmission. Noise, rattle and thrash in the gear train are eliminated for smooth, quiet clutch operation.



International model C-130 Dump Truck equipped with Rockford Spring-Loaded Clutch

See us at the
Milwaukee S.A.E. Show
Sept. 11 to 14

4 HIGH-TORQUE DESIGN
Powerful engagement springs, properly spaced over the facing area, assure maximum driving contact. Compact, low-inertia design prevents gear clashing and delayed shifting.

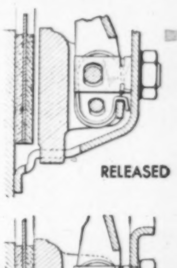
5 SMOOTH ENGAGEMENTS
Dynamic and static balancing assures you of smooth, enduring clutch performance. Both driving and driven members are balanced to eliminate vibration.

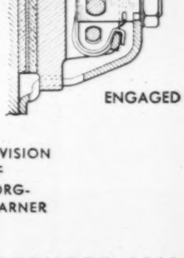
6 HIGH-TEST FACINGS
Using only the highest quality facings, Rockford Clutches give extra-long clutch life, provide cushioned starts, reduce scoring and greatly cut costs of downtime replacement and labor.

7 PERFECT ALIGNMENT
Close-tolerance splined hub assures perfect disc alignment. Through-hardened hub gives long life. Precision manufacturing and rigid quality control eliminate chances for misalignment.

7 Good Reasons Why Idea-Men Count on Rockford Reliability

Above are seven reasons why more and more design men specify Rockford Spring-Loaded Clutches. Equally important, ROCKFORD RELIABILITY is due to 63 years of creative engineering, precision manufacturing and rigid quality control. Rockford offers complete design engineering service at no cost or obligation. You're backed by a worldwide service network. Write today for complete details on ROCKFORD RELIABILITY.


RELEASED


ENGAGED

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1219 WINDSOR ROAD, ROCKFORD, ILLINOIS
Export Sales Borg-Warner International • 36 So. Wabash, Chicago, Ill.

DIVISION
OF
BORG-
WARNER

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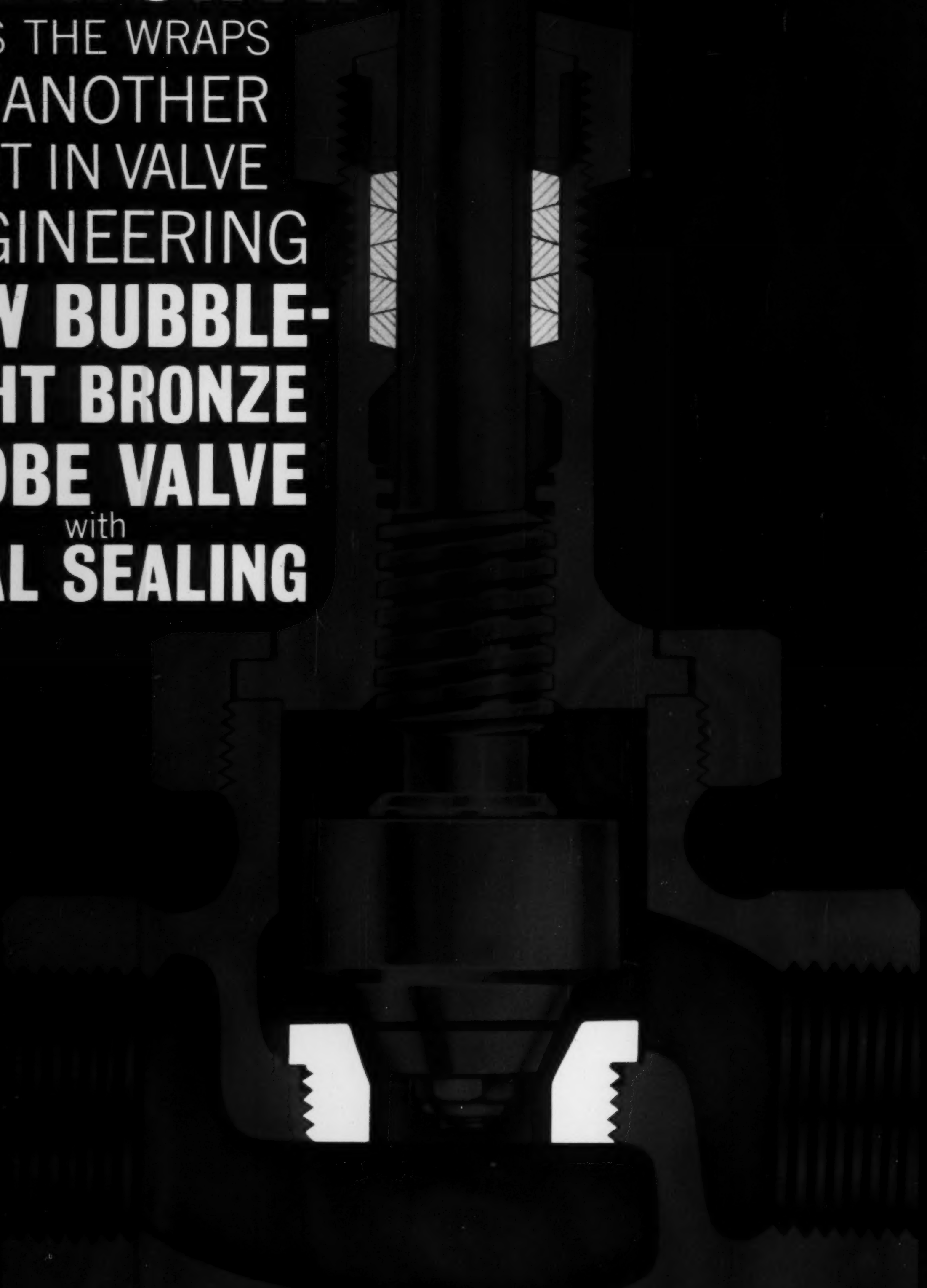
Circle No. 170 on Readers' Service Card ⟶

WALWORTH

TAKES THE WRAPS
OFF ANOTHER
FIRST IN VALVE
ENGINEERING

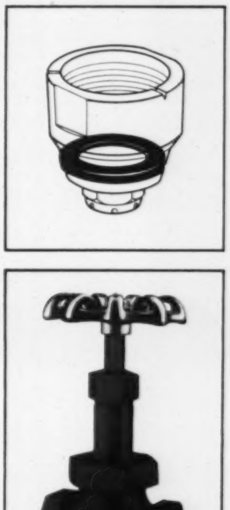
NEW BUBBLE-TIGHT BRONZE GLOBE VALVE with DUAL SEALING



ABSOLUTELY BUBBLE-TIGHT!

Here's the newest concept in valve design. Resilient unplasticized resin insert gives absolute shut-off in critical piping—at low torque. Now available for your particular requirements, the new Walworth Bubble-Tight Bronze Globe Valve is already in service aboard nuclear submarines, and in cryogenic gas piping systems—and is particularly suitable for the most critical water, oil and gas piping systems.

DUAL SEALING This unique unplasticized resin insert provides full 360° seal against matching monel seat. Secondary metal-to-metal seating further assures tightness... consistently. Write for descriptive bulletin.



WALWORTH

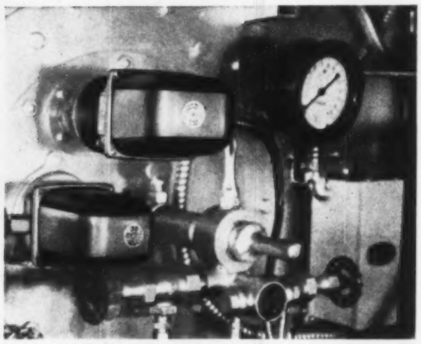
750 THIRD AVENUE, NEW YORK 17, NEW YORK

The Walworth Companies: Alloy Steel Products Company ■ Conoflow Corporation ■ Grove Valve and Regulator Company ■ M&H Valve and Fittings Company ■ Southwest Fabricating & Welding Co., Inc.

Burner flame on?

New FLĀMON Detector

can help you be sure!



Two FLĀMON Detectors installed for independent monitoring of main burner flame and pilot flame of a gas-fired boiler.

Properly installed, the FLĀMON Detector *responds only to the flame it surveys.* Glowing refractories—or flames from adjacent burners—do not produce false signals. Positive monitoring of each burner is assured. Absence or failure of flame is sensed and accurately signaled—and transmitted to control auxiliaries—without use of external relays or amplifiers.

Key to automation . . . the FLĀMON Detector provides the key to reliable automatic light-off and shutdown.

Provides wide temperature range . . . the FLĀMON Detector can be used in ambient temperatures from −20 to 150°F. Flame-sensing element withstands temperatures up to 500°F.

Allows easy inspection . . . quick-disconnect, keyhole mounting simplifies checking of lens condition and detector alignment.

Simple, solid-state circuitry . . . the FLĀMON Detector unit contains only 10 components.

Weatherproof construction . . . design of Bailey unit makes it suitable for outdoor installation.

Your local Bailey Engineer can give you a demonstration of the FLĀMON Detector. Call him, or write Cleveland.

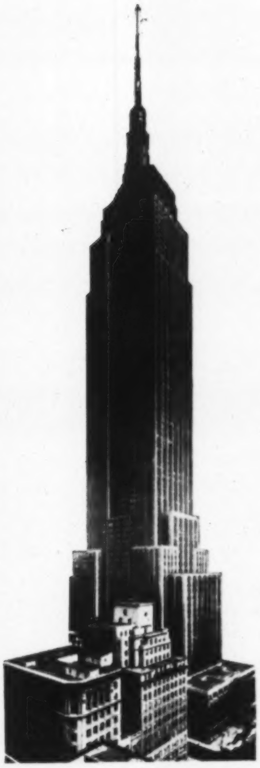
BAILEY METERS

A 162-1

Instruments and controls for power and process

BAILEY METER COMPANY
1026 IVANHOE ROAD • CLEVELAND 10, OHIO
In Canada—Bailey Meter Company Limited, Montreal

Circle No. 19 on Readers' Service Card



How Empire State Building and American Airlines solved vital fire protection problems with

EVERLASTING VALVES

Circle No. 51 on Readers' Service Card

102 stories, 1,472 feet high, 16,000 tenants and 35,000 visitors sum up the fire protection problem of the Empire State Building. An in-building fire protection system is necessary to an unfailing water supply.

American Airlines loading bridge, shown below, gives passengers positive protection against fire with a unique deluge system.

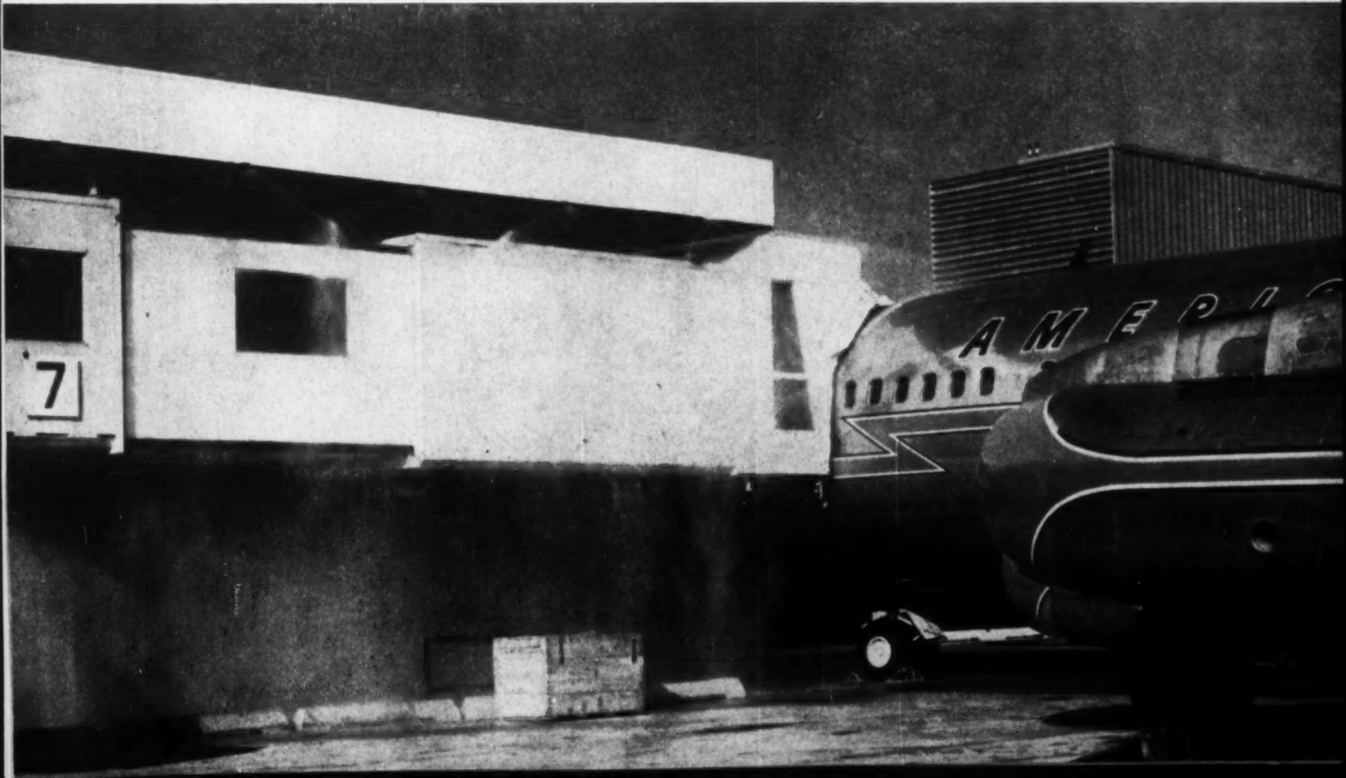
Both these fire protection systems depend on Everlasting Pendulum Stop Valves, which have been installed in thousands of critical fire protection systems over the past 35 years.

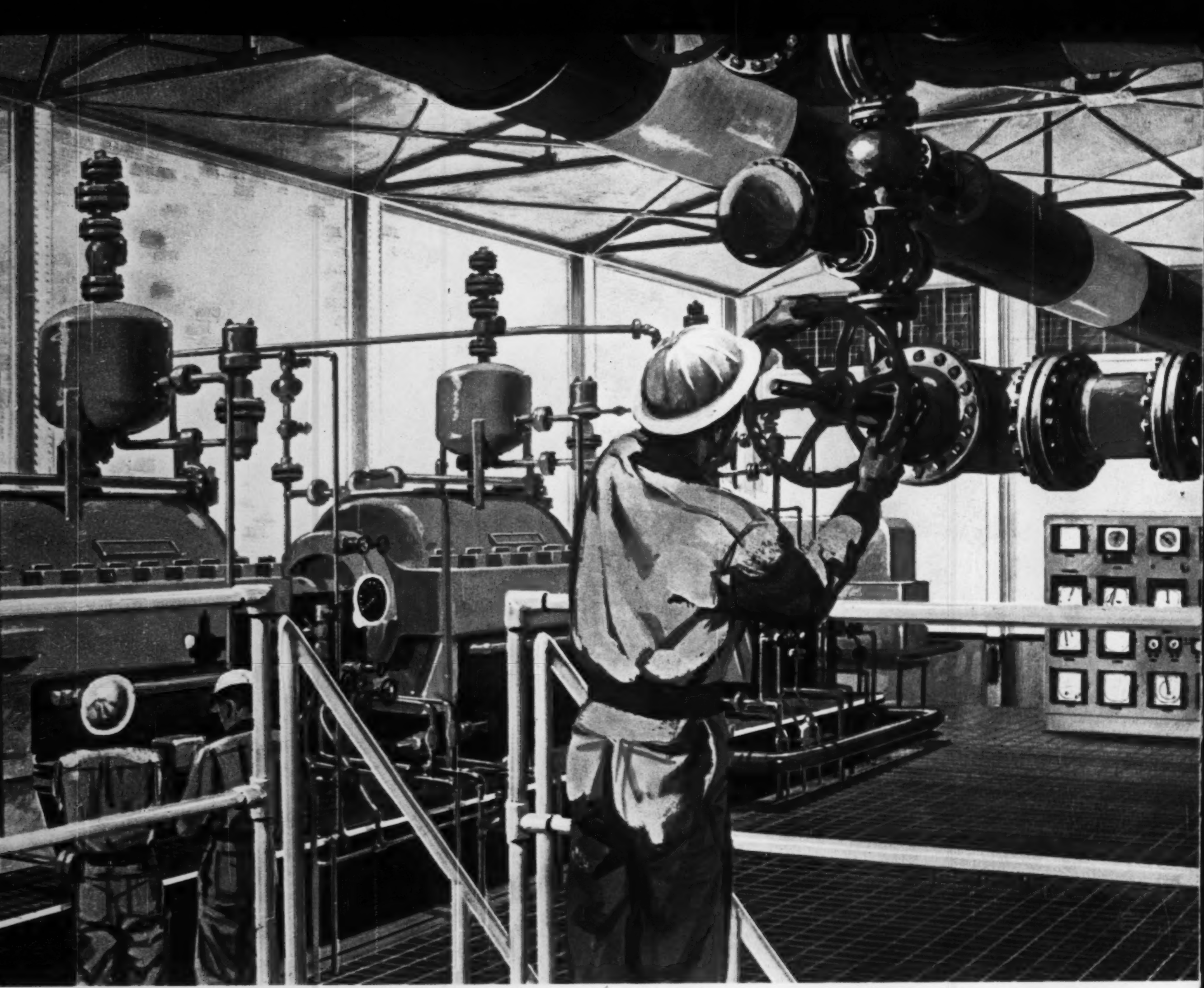
For complete information on the unique American Airlines and Empire State Building systems, write for bulletins F. They include an editorial description of both these installations and a bulletin describing Everlasting's positive action pendulum stop valves.

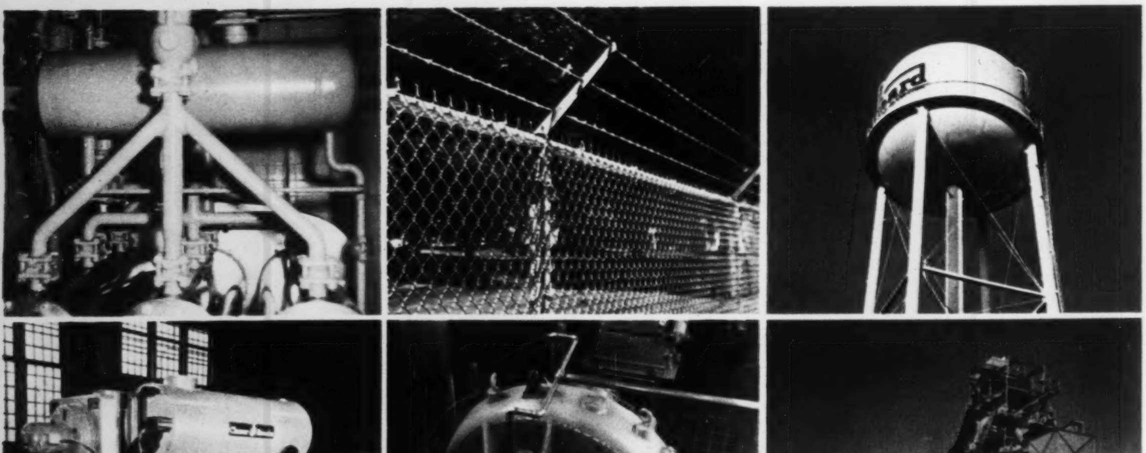
Everlasting also makes a line of quick-opening valves for general service, boiler blow-off, and handling viscous materials, as well as a line of cylinder-operated valves. Bulletins on all these valves are available. **Everlasting Valve Company, 80 Fisk Street, Jersey City 5, New Jersey.**

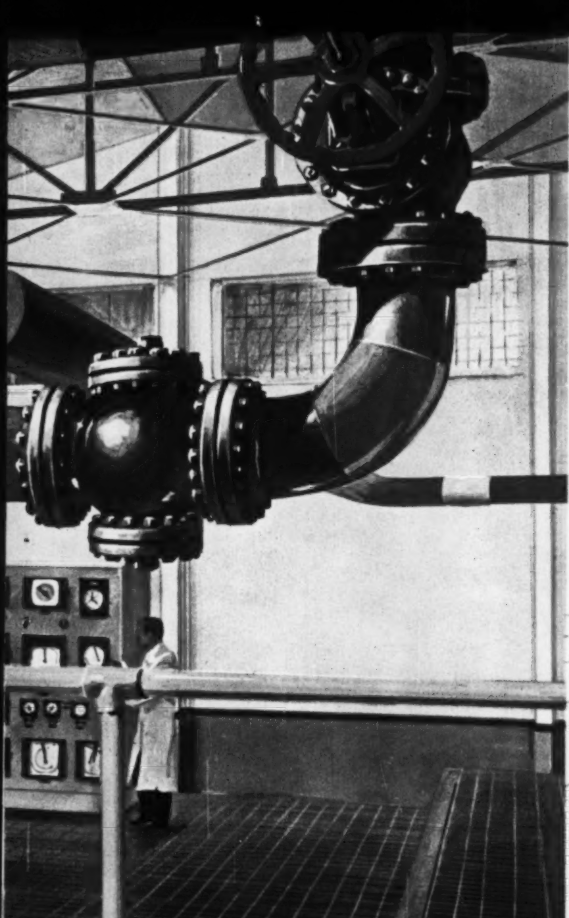
Circle No. 114 on Readers' Service Card →

EV 410









Rust-Oleum

NEW COLOR HORIZONS

System

Here is a modern, functional *system* that combines four important points. (1) the ability to stop rust, (2) modern color harmony, (3) durability to last and last, (4) ease of application. From machinery, equipment, and structural steel to tanks, steel fences and metal sash – the Rust-Oleum New Color Horizons System can provide lasting beauty in the colors of your choice. Ask your Rust-Oleum Industrial Distributor, together with your Rust-Oleum Factory Specialist, to make a survey of your plant and provide complete recommendations. Rust-Oleum Industrial Distributors maintain complete stocks for prompt delivery in all principal cities of the United States, Canada, and in many countries around the world.

Rust-Oleum, in its various forms, can also save you time and money on problems like these: Heat Resistance, Water Resistance, Chemical Resistance, Coating Galvanized Metal, Speedy-Dry Coatings (less than thirty minutes to dry).

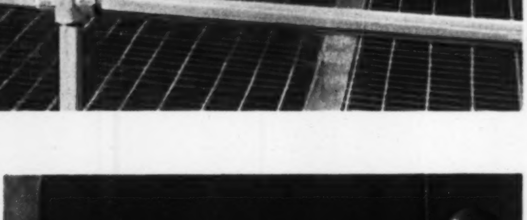
PROVED THROUGHOUT INDUSTRY FOR OVER THIRTY-FIVE YEARS

RUST-OLEUM®

See our catalog in Sweet's.

STOPS RUST!®

Distinctive as your own fingerprint. There are imitations, but only one Rust-Oleum.



STOP RUST by applying Rust-Oleum 769 Damp-Proof Red Primer directly over the sound rusted surface

Save time, money, and metal. Brush Rust-Oleum 769 Damp-Proof Red Primer right over the remaining sound rusted surface after scraping and wirebrushing to remove rust scale and loose rust. **Specially-processed** fish oil vehicle penetrates rust to bare metal as proved in radioactive tracing studies.

RUST-OLEUM
STOPS RUST!

Insist upon industry-proved Rust-Oleum. Accept no substitute.

You take the brush! Try a free test sample!

ATTACH TO YOUR LETTERHEAD

RUST-OLEUM CORPORATION
2985 Oakton Street • Evanston, Illinois

At no cost or obligation, please send me:

☐ New full-color catalog on New Color Horizons System and specialized Rust-Oleum systems, including color charts and applications.

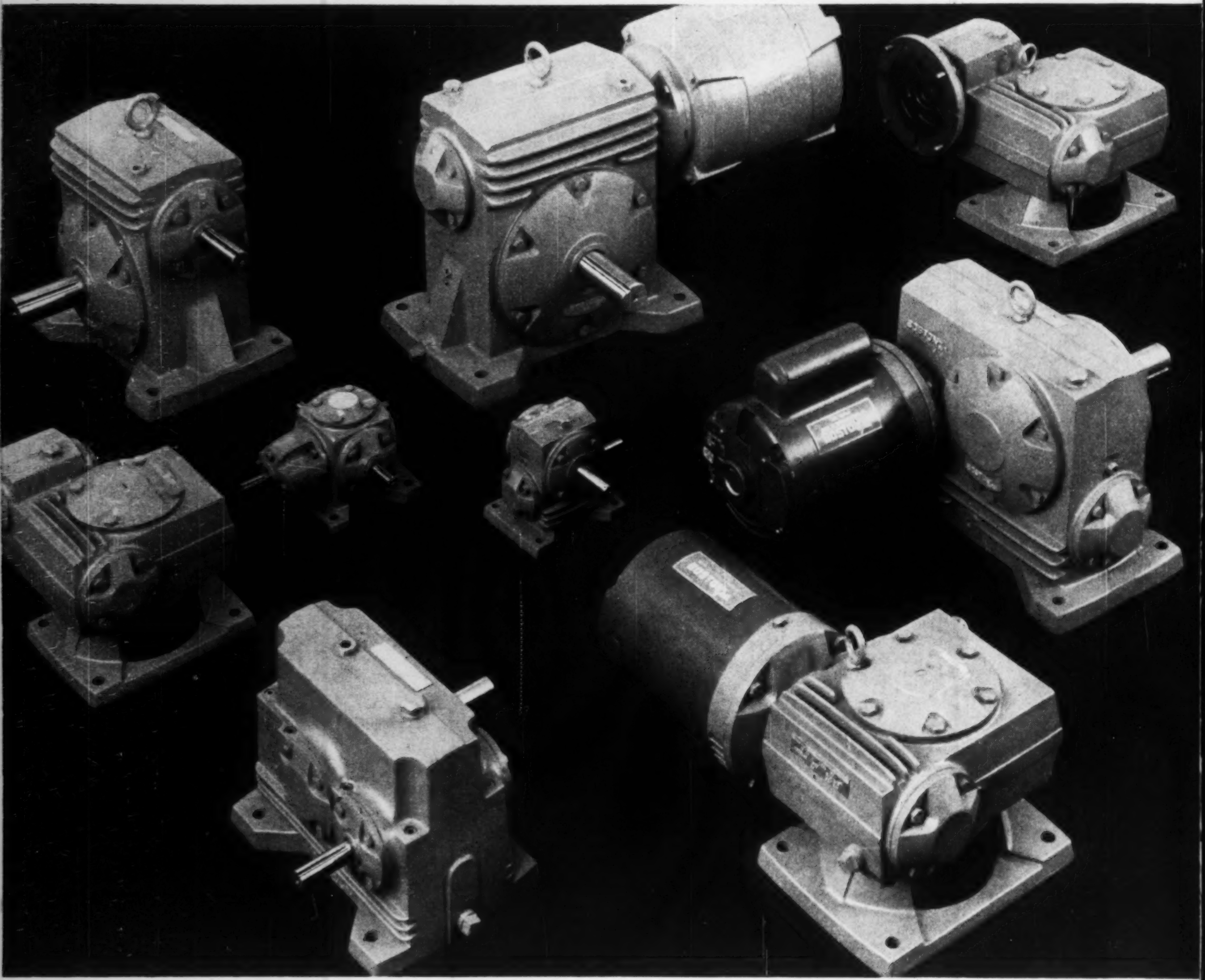
☐ FREE TEST SAMPLE of Rust-Oleum 769 Damp-Proof Red Primer.

☐ Please have your representative contact us to discuss a plant survey.

BOSTON Gear® QUALITY

time-proved REDUCTOR® and RATIOMOTOR® reliability

largest selection for worm-geared drives **from stock**



Horizontal or vertical, right angle or parallel, single or double reduction.

Reductors – for .10 to 15 HP drives – ratios 1:1 to 3600:1.

Ratiomotors – .035 to 10 HP – output torque 4 to 9400 in. lbs.

Detachable motor design. Motor can be changed in minutes.

Ratiomotors sold also without motors as **Flanged Reductors**.

1605 stock sizes, types, ratios. See Catalog 57 for complete listings.

IN STOCK at your nearby DISTRIBUTOR

BOSTON Gear®

© Boston Gear Works, 1961
Quincy 71, Mass.

Circle No. 24 on Readers' Service Card

Self-supporting pipe arch carries gas at 880 psi over 150-foot span

Midwest shop-fabricated this self-supporting river-crossing arch which was installed in a single day by Laclede Gas Company of St. Louis. Formed by converging pair of 16″ pipes, the arch is the only one of its kind in the country.

Structurally a compressive member (except for lateral loadings), the arch becomes a tension member when acting as the carrier pipe for gas under high pressure. Allowance had to be made for a five-foot difference in elevation at the ends of the arch. No expansion joints were required for the arch, since it acts as its own expansion loop. This unusual river-crossing arch is capable of carrying 200 million cubic feet of gas daily at 880 psi.

For complete information on Midwest Piping's products and services, write for Bulletin 60B; POWER AND PROCESS PIPING.

MIDWEST PIPING

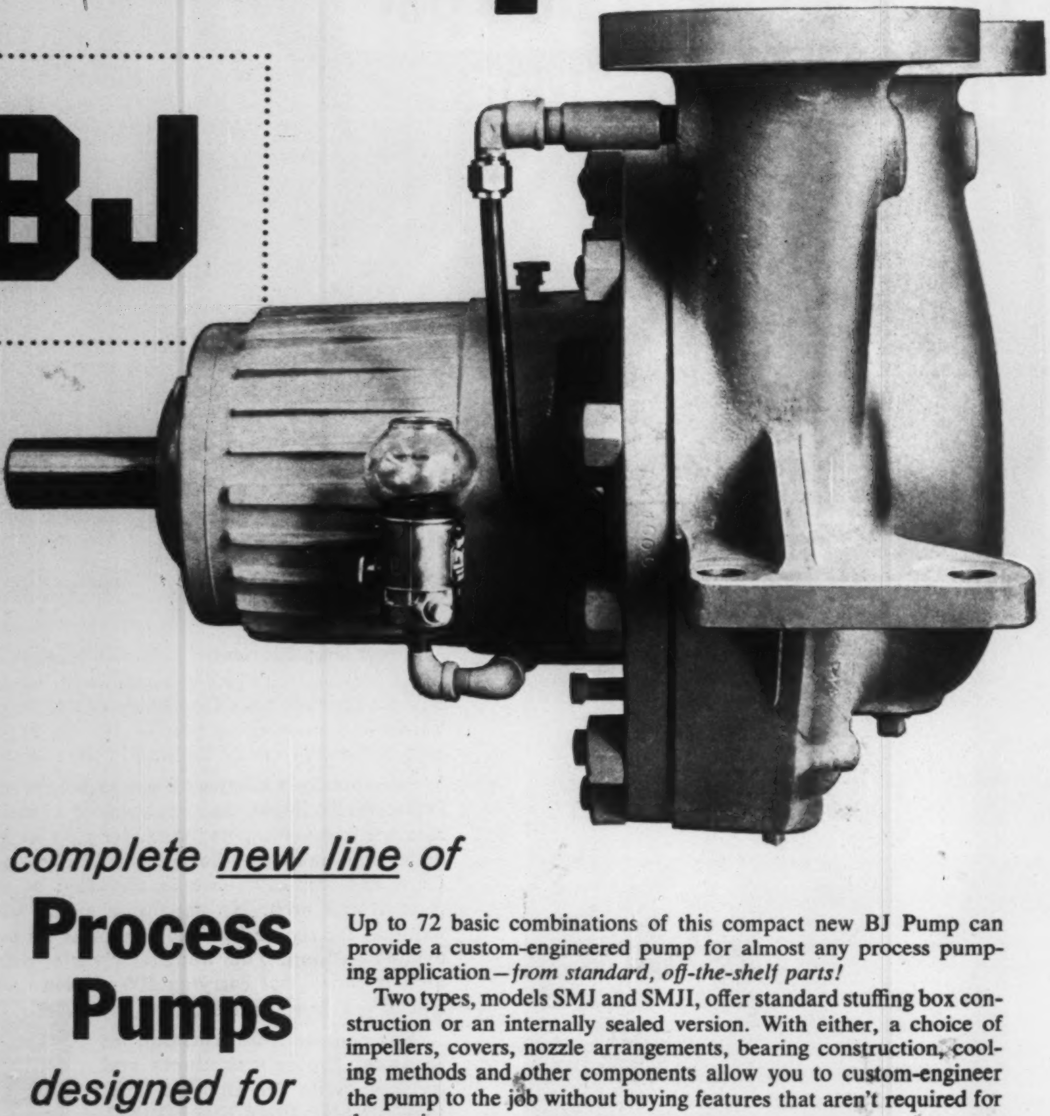
A Division of Crane Co. 1450 South Second St. • St. Louis 4, Missouri

6151

Circle No. 90 on Readers' Service Card

Compact!

BJ



A complete new line of

Process Pumps

designed for maximum interchangeability

Up to 72 basic combinations of this compact new BJ Pump can provide a custom-engineered pump for almost any process pumping application—*from standard, off-the-shelf parts!*

Two types, models SMJ and SMJI, offer standard stuffing box construction or an internally sealed version. With either, a choice of impellers, covers, nozzle arrangements, bearing construction, cooling methods and other components allow you to custom-engineer the pump to the job without buying features that aren't required for the service.

Also, standard, interchangeable parts simplify stocking where a number of different pump applications exist in a single plant, and the compact design saves valuable floor space when installed.

Centerline supported, single stage, the SMJ and SMJI are vertically split with either top or end suction.

Model SMJ is suited for high temperature service to 850°F, and the SMJI for a maximum of 400°F. Both are available to 1,200 gpm, and with heads to 700 feet and pressures to 700 psi!

Fan Cooled*!

Models SMJ and SMJI Process Pumps

Now an exclusive *fan cooled* bearing housing available on Byron Jackson SMJ and SMJI Model Process Pumps can entirely eliminate a cooling water supply to the bearings! This feature was designed to eliminate engineering, installation, maintenance and operation costs of a cooling water supply, and can prevent costly freeze-ups in severe climates.

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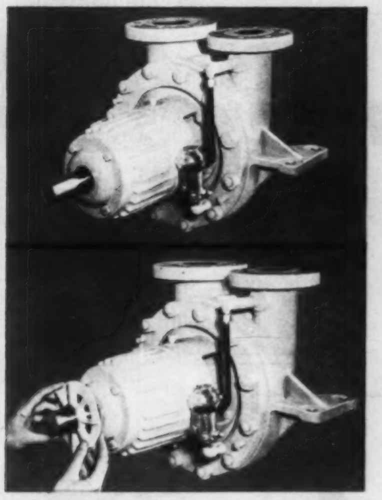

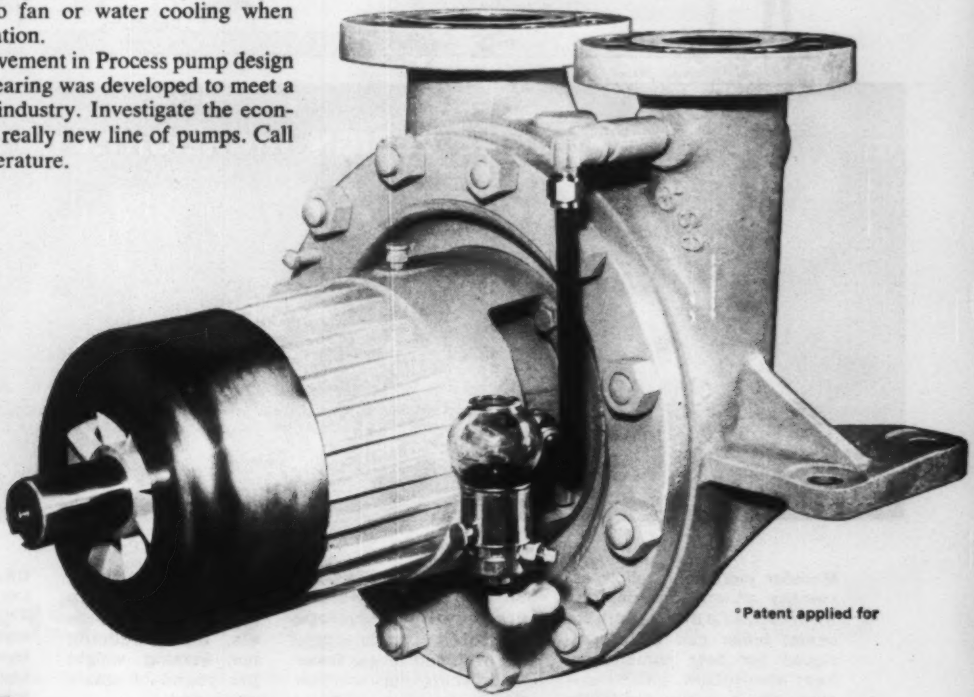

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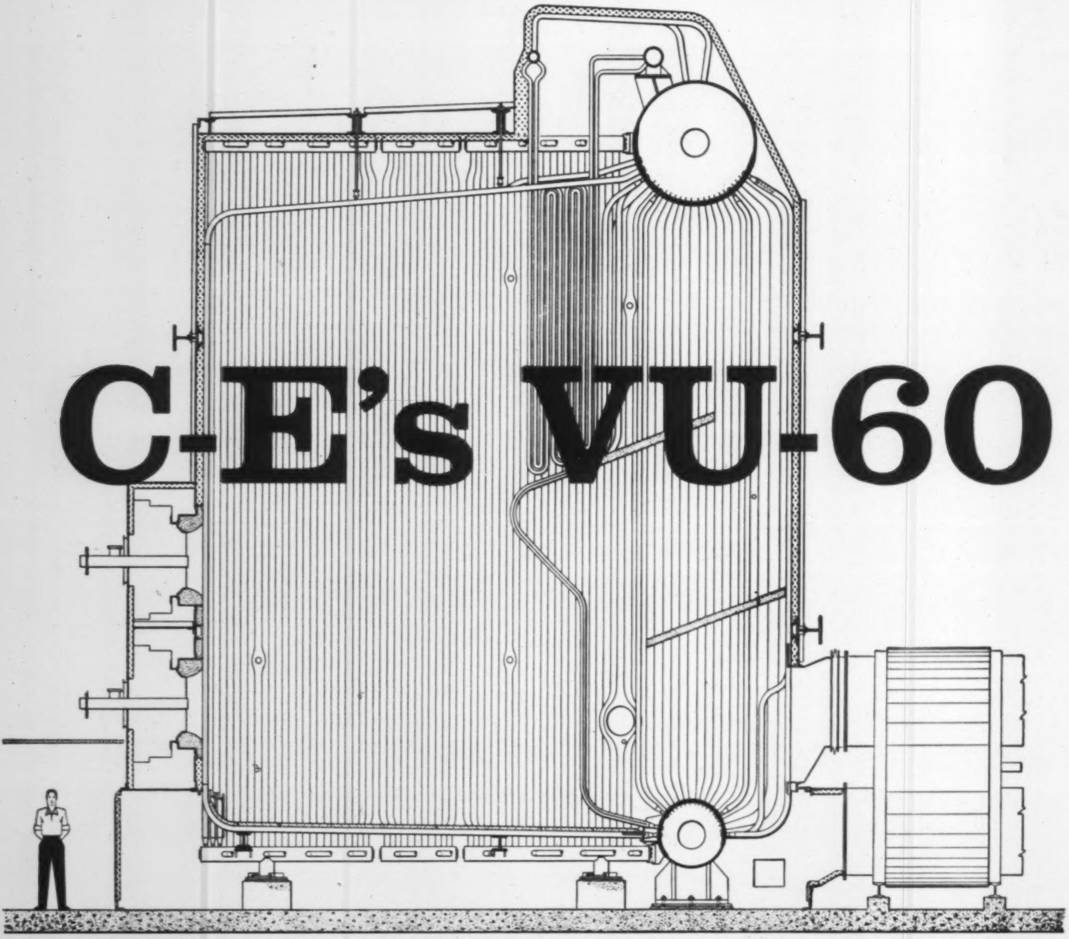


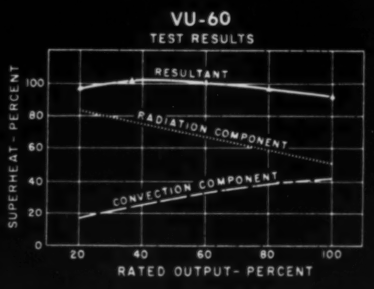
C-E's VU-60

SOME DESIGN HIGHLIGHTS OF THE VU-60

Modular increments allow assembly of custom designs from standardized components; boiler can be proportioned for best combustion, heat absorption, gas flow — even where space conditions are difficult.

Completely self-cased, the VU-60 is an all-welded pressure-tight envelope composed of modular panels of finned tubes; fewer field welds cut erection time.

Insulation and preformed lagging go directly over tube panels, thus reducing non-working weight per pound of steam generated.



Characteristic of Combustion's VU-60. This superheater curve indicates a temperature stability throughout entire load range.

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GIVES YOU A CUSTOM-DESIGNED BOILER BASED ON STANDARDIZED MODULAR COMPONENTS

Because of its unique modular concept, C-E's new VU-60 offers unusual flexibility and can be designed to meet unusual or difficult space conditions.

VU-60 SPECIFICATIONS

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Steam temperatures:	to 900F
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Firing:	Horizontal (front wall) or tangential
Size increments:	Depth-twelve Width-eight Height-three
Steam drum sizes:	Four

The VU-60 is a completely self-cased boiler. Finned tubes, shop-welded into modular panels, make up the exterior walls of the unit. The fins joining the panels are field-welded to make a pressure-tight envelope. Insulation is applied directly over these walls and is covered by pre-formed, field-installed metal lagging. The need for bulky or heavy nonworking structural members is kept to a minimum.

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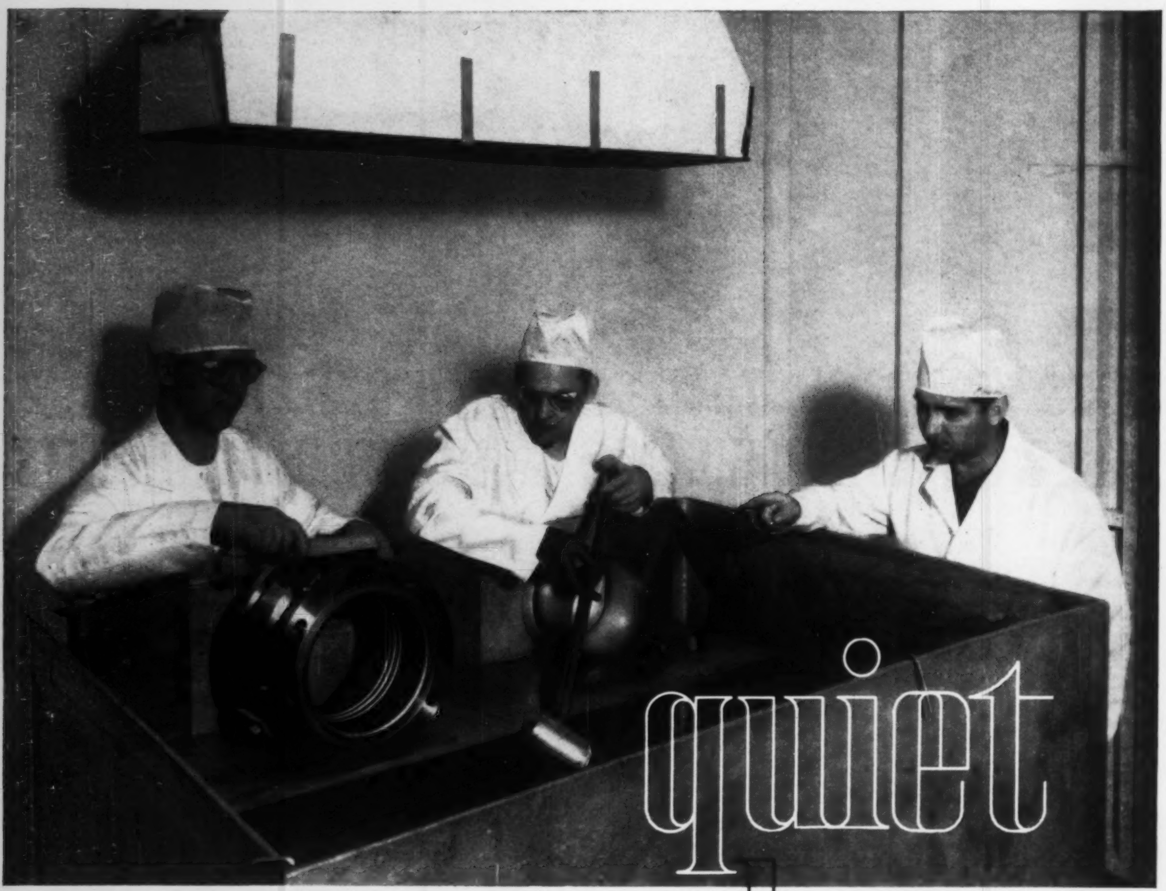

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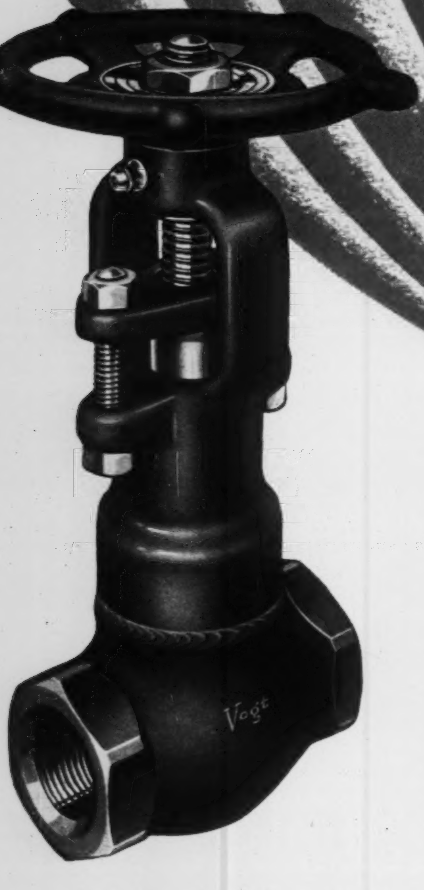

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MECHANICAL
ENGINEERING

VOLUME 83 • NUMBER 9 • SEPTEMBER 1961

Will we be Second?

Editor, J. J. JAKLITSCH, JR.

MORE and better engineers are required if this country is going to win its cold-war battle with communism. So said Rear Admiral Eugene J. Peltier, Chief of Navy Civil Engineers, at a recent meeting of the Society of American Military Engineers and the Technical Society of Knoxville, Tenn. "If our nation is to compete successfully with the forces of communism," he warned, "we must take positive steps to assure that our technological progress will be as great if not greater in the future than it has been in the past."

Admiral Peltier emphasized the need to instill dedication to cause in young engineers. To do so, he suggested that the professional engineering societies arouse a more active group leadership for student chapters and enlist the services of outstanding engineers to appear before students. (ASME has the machinery for such a program.)

We salute Admiral Peltier. But at our present pace there is dim hope of ever achieving the goals he sets in our technological scrap with the communists. For instance, the USSR is graduating 117,000 engineers each year compared to 38,000 in the United States. And Soviet plans call for increases in the future. This information comes to us by way of an Engineers Joint Council report based on an EJC tour of the Soviet Union by U. S. representatives last year. (The 112-page report, "Training, Placement, and Utilization of Engineers and Technicians in the Soviet Union," is now available from EJC, United Engineering Center, 345 East 47th Street, New York 17, N. Y., at $1 a copy).

The six sections of the report cover (1) Engineering and Technicum Education in the USSR; (2) Planning of Manpower Requirements and Placement of Graduates; (3) Continuing Education of Engineers and Technicians Employed in Soviet Industry; (4) Motivation in Education; (5) Industrial Research; and (6) Utilization of Engineers and Technicians.

Recent achievements and future goals of the USSR in the field of engineering and engineering education as set forth in this book are startling. For example, Soviet Russia now has a technical manpower pool equal to the United States, and it plans to increase it by 57 per cent by the end of 1965. Unless we increase our own output of engineers, by 1965 the Russians will outstrip us in engineers by 1,725,000 to 1,100,000.

Throughout the report there are indications of the impressions made upon the delegation by the serious determination and zeal with which the people of the USSR approach technical education. It was pointed out that Soviet secondary education prepares highly qualified students for advanced education, and that the Soviet "freshman" generally is better prepared for an engineering education than his American counterpart.

And the concluding observation in the report—which well might prove to be an epitaph for the United States: The Soviet government and the Soviet people have as a goal the surpassing of the United States economically, and the "burying of us" figuratively. They also believe they will beat us politically by convincing others that their system produces, for everyone, a better way of life and a higher standard of living than our own. They are a long way from our standards now, but they are still sacrificing consumer needs in their drive to industrialize their country. They are expanding at a far greater rate than we are, although they are working from a lower base. However, unless we exert ourselves and put forward our best efforts, the gap between us will disappear all too soon, and we shall find ourselves behind—in second place—with all that can mean to our future welfare.—*J. J. Jaklitsch, Jr.*

The Manufacturer

Two Points of View

The Consultant

FREE? ENGINEERING

By F. C. Heller,[1] Mem. ASME, The Babcock & Wilcox Company, Philadelphia, Pa.

The manufacturer's view. How far should he go beyond normal production engineering? Do the "package," or "island," concepts result in ultimate economy?

> "Free engineering...is the practice of concealing charges for providing professional engineering services in connection with furnishing materials, equipment, or labor of construction."
>
> **Board of Directors**
> **Consulting Engineers' Council**

The view taken here will be that of a capital-goods manufacturer of major equipment for the industrial and utility field.

There is, of course, no such thing as "free engineering." It appears to be free, when in effect it is better termed "hidden engineering" since in the long run the buyer must pay the costs if the manufacturer and the consulting engineer are to stay in business. What we are interested in doing is holding down the engineering costs to the minimum. Manufacturers of capital goods must be able to sell their engineering know-how and ingenuity, otherwise the purchase of major equipment becomes similar to the purchase of scrap iron or sand, with the seller having the lowest price per pound receiving the award.

Consider the type of engineering the manufacturer has to sell. Due to the ability of his engineering staff, he has provided unique advantages and benefits to the user because of the particular type of equipment which he furnishes, as, for example, a better method of firing fuel, which burns lower-cost fuel with a cleaner stack.

Convincing the Buyer

To convince the buyer of the worth of this engineering design, it would be necessary for the manufacturer to furnish arrangement drawings showing the space required, and listing weights so that the cost of foundations could be estimated. In addition, it would be necessary to furnish engineering information in the form of performance figures giving the amount of fuel fired, efficiencies, flow rates, draft requirements, and so forth.

To assist in this evaluation, it might also be necessary for the manufacturer to furnish information on equipment closely tied into his own, such as fans and combustion controls. As a manufacturer, we consider this engineering to be part of our normal overhead, just as other industries consider the cost of advertising in magazines, or on television shows, part of their overhead to get the story of their products to the ultimate buyer.

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[1] Based on a paper contributed by the Professional Practices Committee and presented at the Panel Discussion on Free Engineering at the Winter Annual Meeting, New York, N. Y., Nov. 27–Dec. 2, 1960, of The American Society of Mechanical Engineers.

By J. G. Hoad, Mem. ASME, John G. Hoad & Associates, Inc., Ypsilanti, Mich.

A consultant looks at "free" engineering. Under what circumstances—and to what extent—may it be approved? What does it do to engineering as a profession?

From the viewpoint of the engineering consultant, free engineering may be defined as engineering services offered to, or performed for, a customer without specifically charging for it. In the general field of construction and the installation of new machinery and equipment, such free services may include:

1 Basic engineering studies and reports. These might cover feasibility studies, general designs with preliminary layouts and cost estimates, steam and electric-power surveys, and facility planning.

2 Engineering related to the procurement of machinery and equipment which go into new construction. This ordinarily includes the writing of specifications for equipment, the solicitation of proposals, and the evaluation of bids.

3 Preparation of detailed plans and specifications for construction. This phase of engineering usually requires the bulk of engineering man-hours for a particular project. It encompasses all civil, electrical, mechanical, and chemical engineering. Uninformed or nontechnical management has difficulty in realizing the extent of engineering effort which this phase of the work requires.

4 Preparation of the contract documents necessary for construction, the solicitation of construction bids, and the final awards of the work.

5 Supervision of construction. This work includes the day-to-day inspection of workmanship, materials of construction and construction methods, testing and accepting equipment, aid in or supervision of start-up, final acceptance of the work, and the preparation of record drawings.

The Masks of Free Engineering

Free engineering can be offered or performed under one or more of the following guises:

1 As a service. For example, an electric utility may provide an industrial customer with plans for the construction of a new substation.

2 To promote sales. Example: The case of a manufacturer of electrical switch-gear and related equipment who would study and report on recommended improvements for a customer's electrical-distribution system, at no cost to the customer, with the hope of later selling his particular equipment for the project.

3 As part of the cost of equipment. This type is easily recognized. The XYZ Company's representative

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Based on a paper contributed by the Professional Practices Committee and presented at the Panel Discussion on Free Engineering at the Winter Annual Meeting, New York, N. Y., Nov. 27–Dec. 2, 1960, of The American Society of Mechanical Engineers.

The Manufacturer

The package boiler was one of the first examples of what has come to be known as the systems type of design. This term has come to mean a group of various components arranged to perform a specific function. Examples include the package boiler to generate process or heating steam; IFS or integrated flight system to correlate all the information needed to direct the flight of an aircraft; and a water-conditioning system to supply completely treated water for a power plant. All these systems have two things in common; first, they assemble many items together to perform a specific task; second, they are marketed by a single manufacturer. The manufacturer furnishes not only product engineering, but also over-all design engineering of a type formerly furnished by consulting engineers.

In the utility field, large manufacturers of turbine-generator equipment are taking on the complete responsibility for designing and furnishing an entire power plant, from the river development to the electrical transmission equipment including all equipment between. In other cases, we find what is known as an "island concept" in which the turbine manufacturer takes all the equipment up to the boiler-room wall, and the boiler manufacturer takes all the equipment on the other side of this dividing line. These may well be considered extensions of the industrial package-boiler concept on a much larger scale both as to the scope of material and complexity of design. They are also considered by many to be examples of what once would have been considered free engineering.

Why is there so much interest in the package or island concept today? To understand, we must go back to the early days of power plant construction when it was a complex procedure to assemble a complete unit. Each major piece of equipment was furnished by a separate manufacturer, and a high degree of skill was required of the engineers to fit them all together for a properly balanced plant capable of operating with good efficiency. As pressures and temperatures increased, manufacturers began to consolidate until, under the present alignment, all equipment required for a complete plant can be supplied by a single manufacturer, most of it from his own shops. This ability to design and supply a complete range of equipment has resulted in the package or systems concept previously described.

The Basic Motivation

The overriding motivation is the rapidly rising cost of building power plants. When we realize that a single-unit utility plant, consisting of a boiler-turbine combination with all the necessary auxiliaries to generate one-half million kwhr, represents an investment of $80 to $90 million, it is easy to realize why management is being hard-pressed to make every effort to reduce costs. A saving of only one-half of one per cent becomes a substantial amount.

The Consultant

tells a prospective customer: "Buy our unit and we will furnish foundation and other drawings."

4 As part of the construction package. The ABC Construction Company tells a prospective customer that, if given the job, they will furnish the plans and specifications either free or as "part of the package."

In some states much of the free engineering is illegal. In Michigan, for example, all the directors and officers of a corporation practicing or offering to practice professional engineering must be officially registered as engineers. Yet some manufacturers and utilities ignore this law. Almost all the state registration laws require that the engineer in responsible charge must be registered in the state having jurisdiction over the work. This is another legal requirement often overlooked by the purveyors of free engineering. Many of the engineers performing free engineering sometimes act outside the scope of the canons of ethics for engineers—in short, they act unethically.

Ethics of the Profession

Three of the canons of ethics that are abused from time to time might be mentioned:

1 "He will not use the advantages of a salaried position to compete unfairly with another engineer."

2 "He will not try to supplant another engineer in a particular employment after becoming aware that definite steps have been taken toward the other's employment."

3 "He will not . . . . indirectly . . . . injure the prospects of another engineer."

Certainly, the engineers on the staff of a utility company who prepare plans and specifications for a new substation for one of their industrial customers at little or no cost to the customer are using the advantages of salaried positions to compete unfairly with the consultants. It would seem difficult to justify a utility rate structure which includes an allowance for the cost of free engineering for certain customers.

What about the manufacturer who tells a prospective customer that, if his equipment is purchased, it won't be necessary to retain the engineering firm of Jones and Smith since he, the manufacturer, will furnish the necessary plans either free, or at cost or as part of the package? He seems to be operating outside the scope of our engineering ethics.

There are many instances of free engineering being performed which are not easily categorized but which surely and inevitably involve a conflict of interest. The canons of ethics cover some of these situations . . . . the foreword, for example, states ". . . . the engineer will discharge his duties with fidelity to . . . . his employers and clients. . . ."

The form of bidding on the package or island concept is not uniform. In some cases, owners have engaged consulting engineers to prepare outline specifications and requirements, and to evaluate bids and make recommendations as to the best offering. Where the material which the manufacturers are being requested to furnish is far outside their normal experience, such as river-front development, it has become necessary for them to engage consulting engineers to assist them in the completion of this part of their proposal. It is obvious in these cases that if the buyer had anticipated eliminating the costs of either his own staff or of a consultant whom he would normally engage directly, he will not realize this saving since the engineering cost will still be there; but it will be hidden in the bid price from the manufacturer.

Other savings the buyer hopes to obtain by buying a complete package at a fixed price undoubtedly include avoiding the hundreds of extras that seem to pop up in the no-man's land which separates the various major contracts under present-day practice. We all know that these extras can wreck an initially attractive estimate.

Another major consideration is unit responsibility. When, for example, a power plant having the steam generator and firing equipment furnished under separate contracts fails to produce the expected efficiency, who is to blame? The owner must decide and try to fix the responsibility where it belongs. In many cases this is extremely difficult due, for example, to mismatching of the components.

Unit responsibility eliminates all this since one manufacturer furnishes both the firing equipment and the heat-absorbing equipment and guarantees it as a single system. Carrying this concept a long step further makes the guarantee of the plant heat rate and performance of all equipment including water-treating plant, boilers, turbines, dust collectors, and draft equipment a logical expectation for the buyer.

Lower Prices—at First

Consider the effect of this type of bidding on the various participants. From the manufacturer's viewpoint, it appears he will have less opportunity to sell the fine points of his individual design. With all the equipment lumped together in one proposal, obviously the major emphasis will be on the bid price, with lowest cost per kilowatt generated being of primary importance. The cost of preparing bids will increase astronomically because, if several manufacturers of turbine equipment are required to bid to the buyer, then each boiler company will have to prepare bids for each turbine company and each auxiliary bid will be similarly multiplied. The buyer's operators will have to relinquish many prerogatives of design selection since, with the lowest bid price carrying the major weight in the award of a contract, manufacturers will be forced to furnish low cost equipment and lay it out in the least expensive manner.

At first, in a highly competitive market, the buyer may well obtain lower prices, but if all bidding eventually becomes of this package type the bids will have to seek a level at which manufacturers can obtain a reasonable return on their investment, otherwise they will be forced out of business.

1 "He will . . . . advise his . . . . client . . . . to engage other experts and specialists whenever the client's interests are best served by such service," and

2 "He will not allow an interest in any business to affect his decision regarding engineering work . . . . which he may be called upon to perform."

In the foregoing, the word "client" and "customer" are really interchangeable. An example: The XYZ Manufacturing Company, in trying to sell a major piece of equipment to a prospective customer, finds itself providing a "package" including some free engineering and the furnishing of the smaller auxiliary equipment as well. It so happens that the XYZ Company also manufactures, or has an interest in another company which manufactures, equipment which will handle the functions of the auxiliaries—but only after a fashion and, let us suppose, at a higher electric power use than other equipment available on the market from a competitor of the XYZ Company. The conflict of interest is clear.

Further, even if the auxiliary equipment made by the XYZ Company was completely satisfactory, the element of an arm's-length transaction—whereby the customer's best interest is assured—is completely lacking.

How Much Data?

There is the matter of how much basic engineering data and information are to be furnished by the manufacturer in the sale of his equipment or system. No one would deny that the manufacturer of a complicated and complex equipment unit or system should provide the engineers with all the basic data and engineering information pertinent to their equipment and machinery necessary to complete the design drawings.

Should the manufacturer go further and provide free engineering, in many cases to the consultants themselves? A consulting engineering firm can enhance its profit on a job when its fee is based on a percentage of the cost of the work in place or cost-plus-a-fee, by taking advantage of so-called free engineering from suppliers. For a professional consulting engineer to accept and use free engineering under the guise of his own work is worse than unethical. It is bad enough when uninformed industrial management coerces legitimate suppliers into providing free engineering, without consultants compounding the error.

Another situation arises—costly, wasteful, and frustrating. The HIJ Company wants to purchase and install certain equipment. Vague and incomplete specifications are prepared by the company's engineering staff and sent to a great number of prospective suppliers. The HIJ Company then "picks the brains" of the specialists from the home offices of the better suppliers—including layouts, new ideas, and the like. This engineering is then passed on to the low bidder who thus profits from the free engineering offered by his competitors in good faith.

An industrial customer may ask for proposals from representative manufacturers, sometimes to incomplete and sketchy specifications, and then select the low bidder and tell him that he can have the purchase order if foundation drawings, or piping drawings, or the equiva-

The Manufacturer

We may find that we have built up our costs due to lost motion and duplication of effort to a point where they are as high or higher than our former method of bidding. At the same time, both the buyer and the manufacturer may have lost their freedom of action.

We can make some improvements without throwing the tried methods completely away. Possibly we should return to a position part way between the old and the new. The present trend of requiring many alternates on both an estimating basis and on a firm price basis is expensive, time-consuming, and wasteful of both the buyer's and manufacturer's time. Consulting engineers, or engineers on the buyer's staff, should be able to prepare feasibility studies based on approximate or estimating figures which all manufacturers can furnish on short notice from data which are being constantly revised to keep them accurate and up-to-date.

Manufacturers can supply more auxiliary equipment in the immediate vicinity of their major pieces of equipment to the mutual advantage of the manufacturer and the buyer. A significant contribution which manufacturers of major equipment, including boilers, turbines, and auxiliaries are making is the pre-engineered or standard design unit. Considerable time is saved in the field since, shortly after an order is placed, the buyer is provided with complete arrangement drawings permitting him to start at an early date on foundations and building structures. Anything which reduces the present three or more years' time required from placing an order to initial generation of power on a large central station unit, would be reflected in real savings to the buyer in interest and fixed charges.

It will always be necessary for the buyer to maintain his own engineering staff or to retain that of a consultant because of the many local problems such as river development, dredging, fuel handling, waterfront or rail head development, piping and miscellaneous services, access roads, and site arrangements, all of which are beyond the scope of a manufacturer of capital-goods equipment.

The Place of the Engineer

Engineers must be the co-ordinators of the entire design. They should prepare specifications covering the scope of the work, operating conditions, and heat rate desired; provide supervision to insure conformance with specifications and guarantees; and furnish arrangement drawings, building layouts, design of foundations and piling, and so forth.

It is apparent that the entire power industry is in a state of flux at the moment. We must discover ways and means to produce this most essential ingredient of our national wealth and well-being at the lowest possible cost and in ever-increasing quantities. We can do so only if we lay aside petty bickering and shifting of our proper responsibility to others, and work together as free and honest men.

The Consultant

lent, are thrown in free. Some kind of an arrangement may be made by the chosen manufacturer since, otherwise, he might lose the order. In this case, the free engineering comes entirely or largely out of the expected profit on the order.

Some companies request firm proposals covering a large number of combinations and alternates, instead of making a comprehensive engineering study and final determination first, which puts an onerous burden for free engineering on responsible manufacturers.

Some of the people in the business of supplying industry with machinery and equipment have complained privately about the free engineering they do, many times against their own wishes. Officers of manufacturing companies have said, in effect: "We would like to design and fabricate the equipment and let you consultants do the engineering."

Voice of the Profession

One of the documents which sets forth the underlying principles of professionalism is the Canons of Ethics for Engineers. It was adopted by the Engineers' Council for Professional Development in 1947 and is incorporated into the constitution of The American Society of Mechanical Engineers. Ethics are not reserved only for registered engineers—or for consultants and their staffs; they are for all engineers, whether they work for utilities, for equipment manufacturers or their representatives, or for contractors.

The application of a truly professional attitude toward free engineering by all of the engineers involved could go a long way toward eliminating the problems which spring from it.

This depends on top management—the top management of the manufacturers, the contractors, and the consultants. The decisions involved are policy decisions, not technical decisions. Further, the concepts of professionalism, unless protected and encouraged from the top down, as well as promoted from the bottom up, cannot grow and remain strong and effective.

The American Society of Mechanical Engineers is in a position to make a unique contribution toward eliminating the major abuses of free engineering. Many active and influential members of ASME come from the top management of utilities, companies manufacturing technical equipment and machinery, engineering consultants, and contractors. Their membership in ASME not only commits them to certain high professional principles but also provides a medium for effective action. They can also contribute immeasurably to the education and enlightenment of present and potential customers and clients, which is, of course, a necessary corollary to co-ordinated action regarding free engineering.

Cryogenic processes . . . colder than 250 F below 0 . . . go to work for Industry. Example: Production of oxygen for steel mills and for chemical plants.

CRYOGENICS AND MECHANICAL ENGINEERING

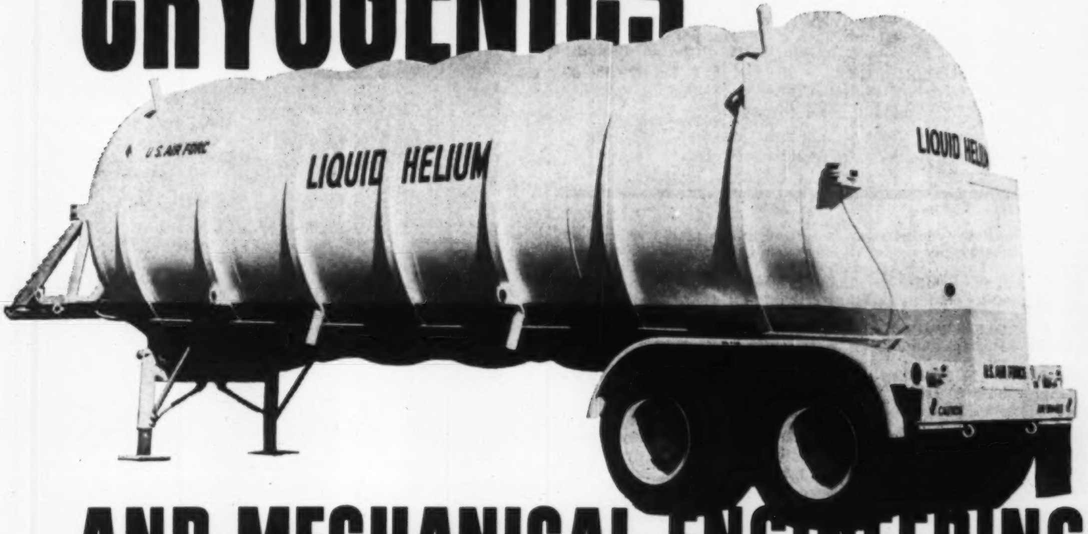

Fig. 1 The development of SI (Super Insulation) and advanced container design have made a 5300-gal liquid-helium trailer possible that is so well insulated there is a no-loss travel time of 20 days at 180-psig relief-valve setting

By G. H. Zenner, Linde Company,
Division of Union Carbide Corporation, Tonawanda, N. Y.

Cryogenics—the production and maintenance of very low temperatures—has been receiving increased attention in recent years. Why all the excitement? And why should mechanical engineers be interested?

Engineers have now devised industrial-size apparatus for liquefying and handling the so-called "permanent gases," Figs. 1 and 2. Low-temperature physicists long ago demonstrated the laboratory feasibility of this. They now continue their work at ultralow temperatures, investigating such unusual phenomena as superconductivity and superfluidity, and carry out experiments which lead to a better understanding of the basic nature of matter.

Two outstanding applications for cryogenics have developed: (*a*) Certain gaseous mixtures can readily be separated to obtain pure components by operations at low temperatures where the difference in boiling points provides the key to the separation; (*b*) a liquefied gas provides a most effective method of concentrating what is otherwise an extremely bulky material.

The data in Table 1 demonstrate these facts for the most important cryogenic fluids in use today. For the purpose of this paper it is assumed that cryogenics is concerned only with operations below −250 F. A few cryogenic gases, especially CO and neon, are omitted because they are currently of minor industrial importance as cryogenic materials.

Methods of Gas Separation

Gaseous mixtures of components having different boiling points can be separated by any of several processes, such as distillation, fractional condensation, absorption, or adsorption. Distillation is important in the separation of air, where the components have boiling points rather close together. Fractional condensation is employed in the initial stages of separating hydrogen or helium from their usual starting mixtures. Here it is possible to achieve effective separation at the temperature of liquid nitrogen, thus avoiding the extra cost and difficulty of liquefying hydrogen or helium merely for

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From a talk presented at a meeting of the Buffalo Section, November 16, 1960, of The American Society of Mechanical Engineers.

CRYOGENICS
AND MECHANICAL ENGINEERING

Table 1 Physical Properties of Cryogenic Fluids

	Boiling point, deg F	Liquid density, lb per cu ft	Heat of vaporization Btu/lb	Heat of vaporization Btu per cu ft of liquid	Cu ft of gas at normal temp and pressure per cu ft of liquid
Oxygen.....	—297	71.3	91.6	6531	862
Nitrogen....	—320	50.4	85.6	4319	696
Argon.......	—303	87.5	70.0	6126	846
Methane....	—259	26.5	219.0	5808	637
Fluorine.....	—307	94.3	74.0	6975	959
Hydrogen...	—423	4.4	193.0	848.7	844
Helium......	—452	7.8	8.8	68.6	754

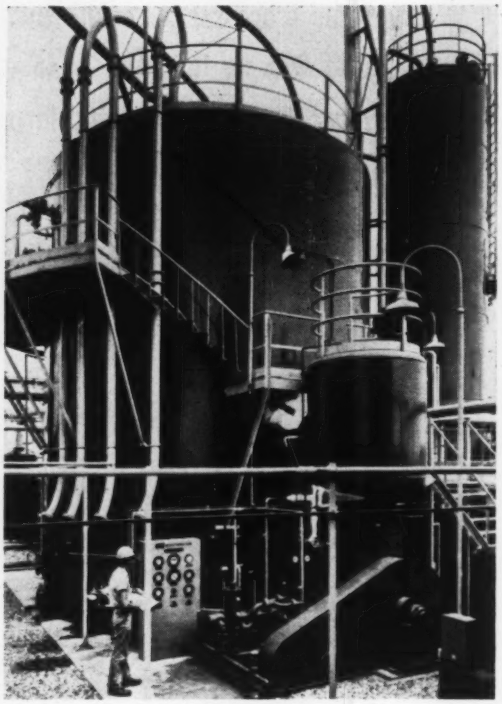


Fig. 2 Purified hydrogen gas is turned into a stable, storable liquid in the liquefier section of Linde Company's liquid hydrogen plant at Torrance, Calif. The liquefier is the large vessel **at left,** the expansion engine is the small vessel in the **foreground,** and the tall slender column **at right** is the purifier.

Fig. 3 A typical flow diagram for a liquid-oxygen production plant using the Heylandt Cycle

Fig. 4 When gaseous oxygen is the product, air need only be compressed to 80 psig and the forecooling step is omitted

Table 2 Average Thermal Conductivities of Insulating Materials Between +70, and — 320 F

Insulating material	Thermal conductivity, Btu per hr-ft-deg F
Perlite (powder) in air..................	18×10^{-3}
Perlite in vacuum (100 μ)..............	2×10^{-3}
Linde CS-5 powder (1 μ)................	0.22×10^{-3}
Linde SI at 0.1 μ........................	0.025×10^{-3}

(1 μ = 0.001 mm Hg abs pressure)

purification. Adsorption or absorption at the temperature of liquid nitrogen is frequently employed as the final purification step.

These methods of gas separation are classic problems in chemical engineering. They are, however, based upon thermodynamics, heat transfer, fluid properties, phase-equilibria data, and mechanical design of equipment so that the mechanical engineer finds the understanding of such processes an interesting challenge well within his basic training.

The most important gas in Table 1, industrially, is oxygen. It was first separated on a commercial scale from liquid air by a distillation process in 1902 by Carl von Linde. Oxygen has widespread uses and, in the form of liquid oxygen, is one of the cheapest and most effective oxidizers used in rocket engines. A typical flow diagram for a plant is shown in Fig. 3.

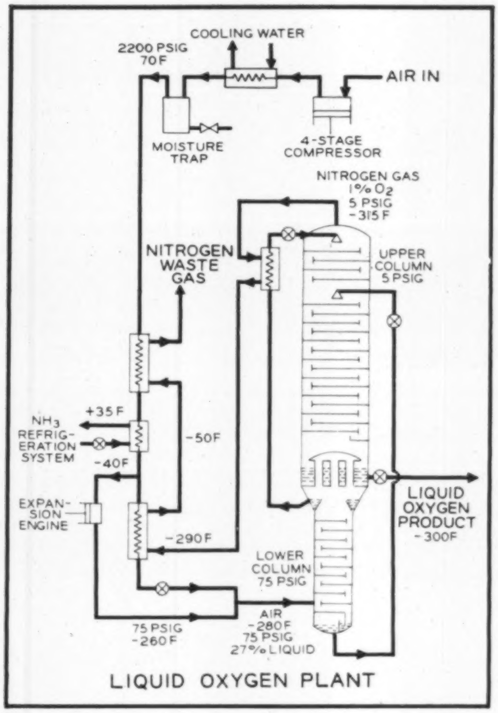
Most of the power required for compression of the incoming air is utilized to produce the refrigeration in the liquid-oxygen product. It will be observed that the refrigeration comes from three sources: (*a*) Vapor-compression refrigeration at about —40 C; (*b*) an expansion engine which rejects work to outside the system; (*c*) Joule-Thomson cooling by throttling a portion of the high-pressure air.

A heat balance of the cycle shows that the maximum amount of liquid is produced when about 50 per cent of the air at 2200 psi is expanded in the engine, the remainder of the air passing through the heat exchanger and being throttled at the cold end. Water in the air is removed in ammonia-cooled forecoolers, which are installed in duplicate (not shown). Carbon dioxide is removed from the liquid-air stream by filters.

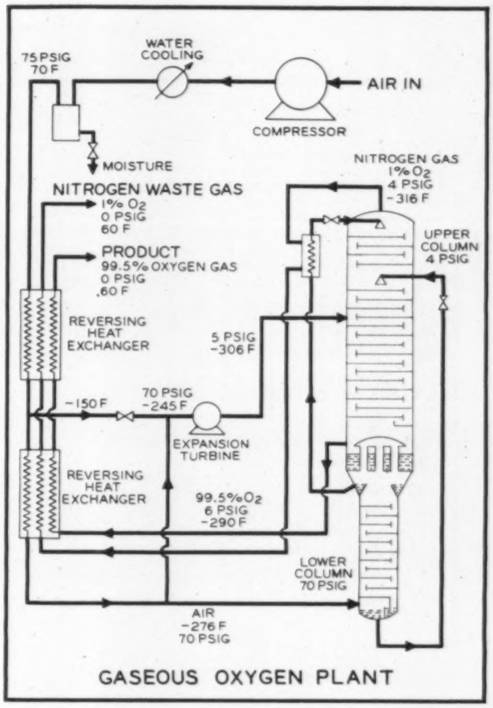
The only element of this plant whose function is outside the usual scope of the mechanical engineer is the distillation column. This simple but ingenious device provides a means for separating air into its components with great efficiency as indicated by the product.

If gaseous oxygen is to be the product of the plant, the air need be compressed to only 75 psig, and the forecooling step is omitted. The power cost of the gaseous product is therefore about one third that of liquid. A typical cycle is shown in Fig. 4. The power invested in the compressed air is here chiefly consumed in the distillation process. Air enters the lower column at about 70 psig so that the nitrogen vapor can be condensed against liquid oxygen boiling at about 5-psig pressure in the upper column. All of the air which enters the lower column as a vapor leaves as a liquid and is throttled to the upper column. Only a minor portion of the entering air is turbine-expanded to provide the refrigeration to balance the system. Currently, there is great interest in large-size gaseous-oxygen plants producing up to 500 tons of oxygen per day. A number of these are being installed on the property of various steel mills and chemical plants, whose huge demands are outside the economic capabilities of the liquid-oxygen system.

The data on liquid densities in Table 1 show that many of the cryogenic liquids are heavier than water. The lightest liquid is hydrogen which weighs 4.4 lb per cu ft or only 9.5 oz per gal. In the last column of Table 1 are shown the volumes of gas at normal temperature


COOLING WATER
2200 PSIG
70 F
AIR IN
MOISTURE TRAP
4-STAGE COMPRESSOR
NITROGEN GAS
1% O2
5 PSIG
-315 F
NITROGEN WASTE GAS
UPPER COLUMN
5 PSIG
NH3 REFRIGERATION SYSTEM
+35 F
-50F
-40F
EXPANSION ENGINE
-290 F
LIQUID OXYGEN PRODUCT
-300F
LOWER COLUMN
75 PSIG
75 PSIG
-260 F
AIR
-280 F
75 PSIG
27% LIQUID

LIQUID OXYGEN PLANT


75 PSIG
70 F
WATER COOLING
AIR IN
COMPRESSOR
MOISTURE
NITROGEN GAS
1% O2
4 PSIG
-316 F
NITROGEN WASTE GAS
1% O2
0 PSIG
60 F
PRODUCT
99.5% OXYGEN GAS
0 PSIG
60 F
UPPER COLUMN
4 PSIG
REVERSING HEAT EXCHANGER
5 PSIG
-306 F
-150 F
70 PSIG
-245 F
EXPANSION TURBINE
REVERSING HEAT EXCHANGER
99.5% O2
6 PSIG
-290 F
LOWER COLUMN
70 PSIG
AIR
-276 F
70 PSIG

GASEOUS OXYGEN PLANT

and pressure obtained per unit volume of liquid. It will be noted that there is relatively little difference in the degree of volume reduction obtained by liquefaction for the different gases and that the ratio is quite sizable (about 800:1). It would require enormous pressures, of the order of 25,000 to 40,000 psi, to achieve such volume reduction by simple gas compression. The weight of a container for such pressures would be prohibitive for use in a missile. Thus missile engineers find themselves engaged in cryogenic engineering whenever they wish to use any of the fuels or oxidizers listed in Table 1. Liquid oxygen and nitrogen have been widely used industrially for more than 25 years. The rather recent importance of these liquids, together with liquid hydrogen in the field of missiles and space vehicles, has been in large part responsible for much of the current interest in cryogenics.

The fifth column of Table 1 gives the heat of vaporization *per unit volume* of these liquids. These data serve to illustrate the relative difficulty of retaining the various liquids in a container. In a space vehicle, liquid oxygen is usually carried in an uninsulated tank, a practice which is feasible only for short-time storage. Liquid hydrogen, however, requires only about 12 per cent as much heat to vaporize a given volume, as compared with oxygen, and in addition there is the further problem that air would condense and freeze on the outside of a bare liquid-hydrogen container, thus giving an enormously increased rate of heat transfer. Liquid helium requires only 1.2 per cent as much heat as the same volume of liquid oxygen. Furthermore, its boiling point is still lower than that of hydrogen. Thus liquid hydrogen and liquid helium require vastly improved insulations in order to retain them with anything like the effectiveness of liquid-oxygen containers.

Importance of Insulation

Advances made in insulation effectiveness demonstrate some of the progress being made. The thermal conductivities of the important cryogenic insulations are listed in Table 2 in the order in which they have been developed.

It will be noted that each improvement is very nearly a complete order of magnitude. All of the insulations except the first require a vacuum.

The SI type (meaning Super Insulation) consists of alternate layers of bright aluminum foil separated by a fine glass-fiber paper or mat, having between 40 and 80 such layers per inch of thickness, Fig. 5. Prior to the advent of the SI-type insulation, it was necessary, when attempting to store relatively small quantities (less than about 500 gal) of either liquid hydrogen or liquid helium, to use a vessel made of four concentric shells. Liquid hydrogen or helium was held within the fourth or innermost shell, while liquid nitrogen was employed as a heat shield between the second and third shells. The spaces between shells one and two, and three and four, were evacuated and the surfaces were of polished copper. This led to a fragile, expensive, and cumbersome construction. Now liquid hydrogen and liquid helium vessels of high insulating efficiency and durable construction are being built, using the new insulations.

In order to store, transfer, and otherwise handle cryogenic fluids, a variety of special equipment has been developed, Figs. 1 and 6. Problems encountered which are peculiar to such equipment and the solutions include:

1 Ordinary carbon and low-alloy steels become brittle at low temperatures. It was necessary to find tough alloys which could also be welded. The principal metals found satisfactory for such service were copper-

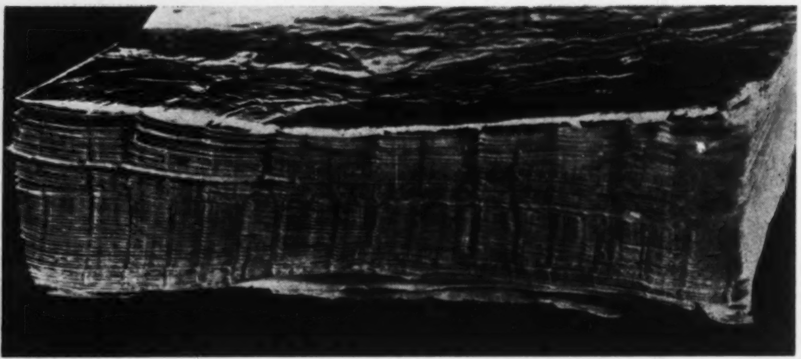


Fig. 5 SI (Super Insulation) consists of alternate layers of thin aluminum foil, acting as multiple radiation shields, supported by layers of a special glass-fiber paper. Density is 4.7 lb per cu ft and there are 40 to 80 layers per in. When used at 0.1 micron vacuum, insulating value is about 30 times superior to vacuum-Perlite.

CRYOGENICS
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Fig. 6 Any preset temperature from ambient to −320 F can be maintained automatically without auxiliary power equipment in the Polarstream system. For use in in-transit refrigeration, it utilizes controlled release of nitrogen from a 40-gal liquid-nitrogen container in the corner of the cargo department.

silicon alloys, austenitic stainless steels, and certain aluminum alloys.

2 Storage and transport vessels generally required a vacuum casing, usually in conjunction with a powder for insulating purposes. This construction required extensive investigations to achieve vacuum tightness. Furthermore, it was necessary to devise means for conducting pipes and supports from the inner vessel to the exterior without introducing problems of extra heat leak or differential contraction. On transport units, it was essential to provide adequate support of the inner vessel against road shocks while also avoiding excessive heat conduction through the structure.

3 Pumps for cryogenic fluids faced severe problems of vapor binding and lubrication of bearings and packings. No normal liquid could be used as a lubricant since all known liquids would freeze. Furthermore, in liquid-oxygen pumps it is necessary to avoid organic materials since they could burn violently or possibly explode.

Such problems are essentially those of mechanical engineering. In addition, the problems encountered in the design of a plant for producing cryogenic products are also either direct applications of mechanical engineering or are closely related thereto.

Applications for Cryogenic Fluids

A number of new applications for cryogenic fluids are in limited use today and others are in various stages of development. Certain of these will undoubtedly become large users of cryogenic techniques or fluids soon. Among these are:

1 Use of liquid nitrogen to preserve living tissues (cryobiology). In the practice of artificial insemination for breeding cattle, liquid nitrogen is now being widely used to preserve semen. Efforts are under way to find similar ways of preserving whole human blood. Such developments will require a variety of containers and specialized cryogenic equipment.

2 Liquid-hydrogen bubble chambers are in use and more are being built for experiments on the nature of the fundamental particles of matter.

3 Certain electronic devices (masers, infrared detectors) can be greatly improved by maintaining vital parts at extremely low temperatures so that the thermal noise is minimized.

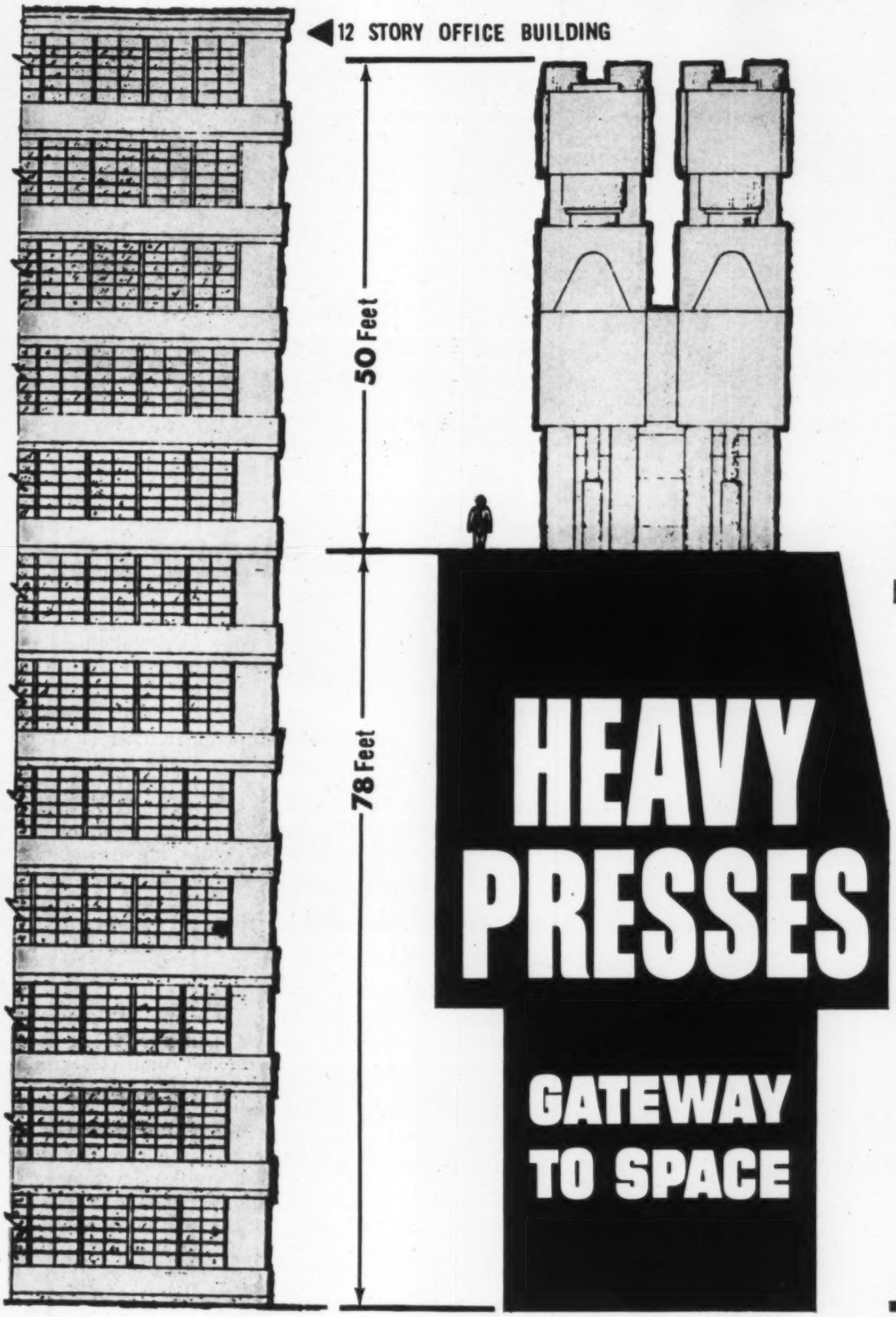
4 Cryopumping provides a means for maintaining a high vacuum while a fluid enters the system. A cryogenic liquid (usually hydrogen or helium) maintains a surface at such low temperature that all normal gases are condensed and frozen to its surface. Cryopumping finds application in the testing of equipment for space applications.

5 Frozen food can readily be maintained at desired low temperatures during shipment by utilizing the refrigeration in a tank of liquid nitrogen.

6 Methane in the form of natural gas is cheap and plentiful in certain parts of the world and in great demand in other areas. A system of liquefying the methane and transporting it as a liquid is being tried out at the present time.

HEAVY PRESSES

GATEWAY TO SPACE



Without heavy presses, our first-line military aircraft would be fewer, lower in performance, costlier. With them, fabrication of efficient missile components becomes possible.

Massive foundations are needed to support the large heavy presses. Total over-all height of this 50,000-ton maximum pressure forging-press is as tall as a 12-story office building. This press weighs 7164 tons and was built by the Mesta Machine Company.

Heavy forging presses were initially conceived in the 1940's to satisfy the need for large magnesium and aluminum aircraft structural forgings. Titanium was introduced in 1955 to meet the requirements of the jet-engine industry. In the past several years, engineering programs have been in progress to develop materials and configurations required for advanced propulsion systems, missiles, and space vehicles. This capability has been developed for a broad range of materials: Beryllium, titanium alloys, nickel-base alloys, refractory metals, and low-alloy and stainless steels in addition to aluminum and magnesium.[1]

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[1] This introductory paragraph was originally part of the summary of the paper by Canal and Kunkler.

Based on three papers contributed by the Aviation Division and presented at the Winter Annual Meeting, New York, N. Y., November 27–December 2, 1960, of The American Society of Mechanical Engineers.

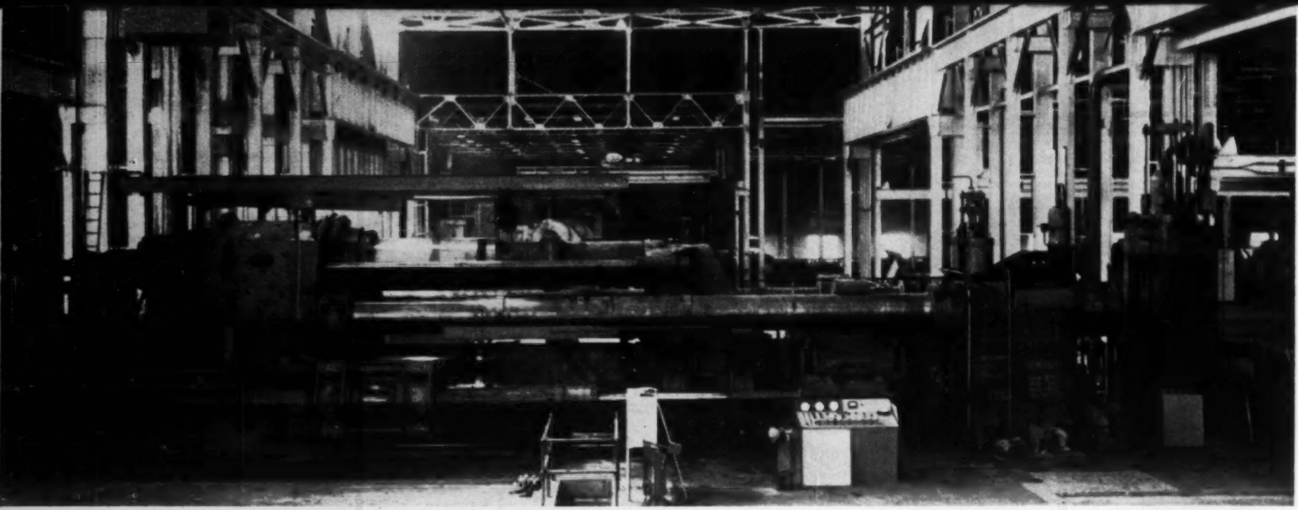

Fig. 1 The heavy-press facilities at Alcoa include a privately financed 14,000-ton extrusion press, similar to the one shown here which is operated for the USAF Heavy Press Program

By L. W. Mayer[3]

HEAVY PRESSES IN THE SPACE AGE[2]

MUCH has been written and said about the evolution of heavy presses, both for forging and extrusion. That most of these presses are in existence at all is a tribute to the foresight and perserverance of the Air Material Command of the United States Air Force and the concerns who built and operate the heavy presses. Without these presses, our current first-line military aircraft would be fewer in number, lower in performance, and greater in price.

Large, homogeneous, and precise structural members offer savings in time and money over their built-up predecessors and, in addition, decrease weight and hence increase performance in any weight-limited structure, be it aircraft, missile, or space vehicle.

Alcoa's Heavy-Press Facilities

In addition to a complete line of privately owned presses, Alcoa operates hydraulic forging presses of 15,000, 35,000, and 50,000-ton capacity, a 25,000-lb steam hammer, and one 14,000-ton-capacity hydraulic extrusion press for the USAF under the Heavy Press Program. An additional privately financed 14,000-ton extrusion press nearly identical to the USAF press is in operation, Fig. 1. All major parts are interchangeable between these two presses, more than doubling the reliability, flexibility, and production capability of either press operating alone.

In addition to the heavy forging and extrusion presses, Alcoa operates a 16,000,000-lb plate stretcher (a 3,000,000-lb stretcher is shown in Fig. 2) and a large heat-treating facility which belongs to the USAF. Both of these have been and are being used extensively on material for military and commercial aircraft programs.

Forged accumulators, head forgings, missile fuel-tank forgings, missile bulkhead forgings, extruded missile skins, a missile wing-support shroud, and the widest multiple-void extrusion ever produced—a hollow electronics shelf—have all been made on USAF heavy forging and extrusion presses.

Development Efforts

In missile and space-vehicle construction, a large percentage of the over-all structure is cylindrical, with or without closed ends. In liquid-fueled missiles, the tankage for fuel and oxidizer usually is the largest single element of the missile, while in solid-fuel missiles the motor case is generally the largest single item. Alcoa has, therefore, devoted considerable developmental effort toward production techniques for large cylindrical

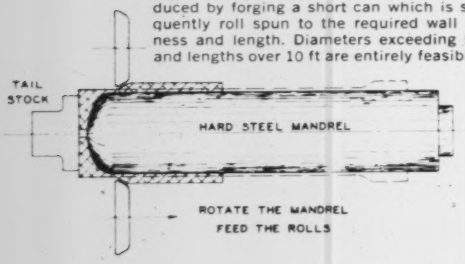

Fig. 3 Large monolithic motor cases are produced by forging a short can which is subsequently roll spun to the required wall thickness and length. Diameters exceeding 50 in. and lengths over 10 ft are entirely feasible.

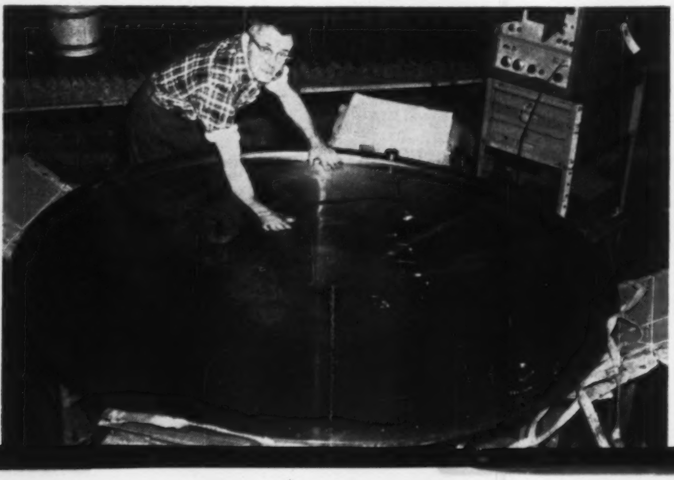

Fig. 4 The beryllium heat-sink forging used on the Mercury man-in-space capsule was produced on the 50,000-ton press

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[2] Condensed from Paper No. 60—WA-288.

[3] Aerospace Section, Sales Development Division, Aluminum Company of America, New Kensington, Pa.

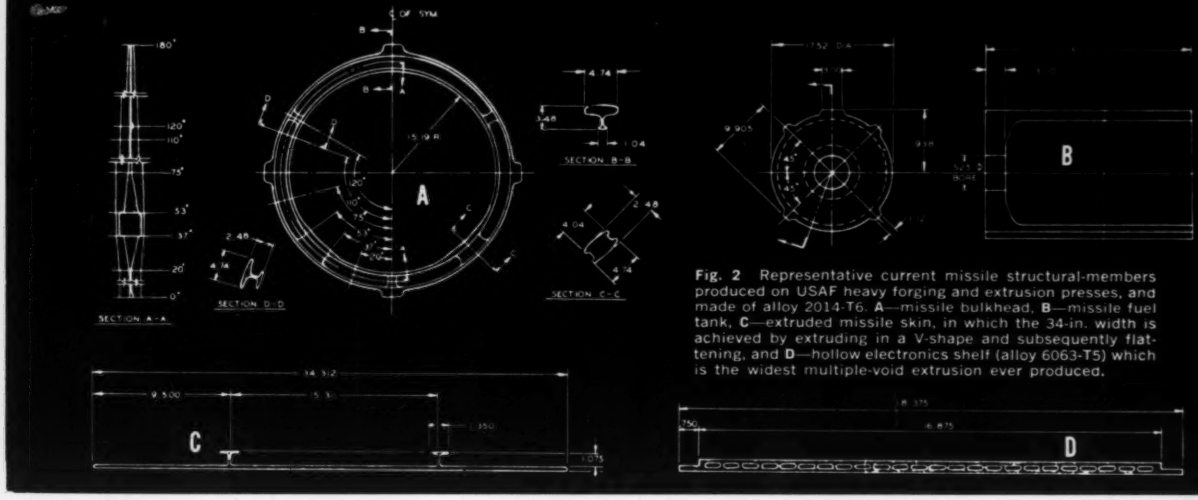

Fig. 2 Representative current missile structural-members produced on USAF heavy forging and extrusion presses, and made of alloy 2014-T6. **A**—missile bulkhead, **B**—missile fuel tank, **C**—extruded missile skin, in which the 34-in. width is achieved by extruding in a V-shape and subsequently flattening, and **D**—hollow electronics shelf (alloy 6063-T5) which is the widest multiple-void extrusion ever produced.

vessels in both applications. Monolithic solid-fuel motor cases have been produced by a combination of forging and extrusion processes. The production to date has been such that heavy presses were not required. However, by using the same techniques on the heavy presses, motor cases up to 26 in. diam and over 10 ft long could be produced. It is interesting to note that the currently available aluminum alloys used in the small cases have shown strength-to-density ratios approaching 1,000,000 in., and circumferentially reinforced aluminum monoliths have exceeded the magic 1,000,000 level in hydrostatic tests. In addition, motors of both configurations have been fired successfully at temperatures ranging from −100 to +200 F.

Another and perhaps a superior method for producing large monolithic motor cases is to forge a short can which would be subsequently roll spun to the required wall thickness and length. Three such shells, after spinning, are shown in Fig. 3. By utilizing the USAF heavy forging presses and commercial spinning equipment which are currently available, diameters exceeding 50 in. and lengths over 10 ft are entirely feasible.

For other specialized and in some cases classified applications, large heavy-walled cylindrical shapes are desired, and a limited number of such shapes have been produced on heavy presses in high-strength aluminum alloys. It should be noted that these are not absolute maximums but, instead, are typical of what can be produced using existing forging and extrusion techniques.

Recently, one of the 14,000-ton extrusion presses has been utilized to extrude the largest aluminum powder-metallurgy alloy extrusion ever produced. This was an 8-in-diam rod to be used as forging stock for one of the USAF heavy presses. These high-temperature alloys can now be supplied in sizes comparable to conventional aluminum forgings and extrusions.

One indication of the versatility of the USAF heavy forging presses is the production of forgings in some of the exotic ferrous and nonferrous alloys other than aluminum. The beryllium heat-sink forging used on the Mercury man-in-space capsule was produced on the 50,000-ton press, Fig. 4. Smaller beryllium closed-die forgings have been produced, as well as a limited amount of work on titanium and Tricent-300 steel.

By Jose R. Canal,[5] Assoc. Mem. ASME, and William C. Kunkler, Jr.[6]

FORGINGS FOR MISSILES AND SPACE VEHICLES[4]

Some of the forging applications of most immediate interest for missiles and space vehicles and for which capability has been or is being developed are: The heat "sink" shield or ablation back-up support, shells and structural components of the re-entry vehicle which, for example, could be made of forged beryllium; the solid rocket motor, domes, and closures, made of steel, titanium, or aluminum forgings; the cylindrical motor section, fabricated by roll-forming extruded cylinders or integral dome skirts; nozzle cones of steel or titanium; nozzle throats, liners, and vanes of molybdenum or a tungsten-base material yet to be developed; aluminum structural components in the liquid-rocket stage, such as titanium pressure bottles, and Waspaloy, René 41, and Astroloy turbine wheels and nozzle rings, Figs. 6–8.

These forgings, with the exception of the small guidance and nozzle parts, are products of the heavy presses at the Wyman-Gordon operated USAF plant at North Grafton, Mass. Presses in this plant range in capacity from the 1500-ton press to the 50,000-ton press shown in Fig. 5.

The original concept of the heavy presses, to produce large integral component forgings of difficult-to-work materials, is as applicable today for missiles and space vehicles as it was nearly two decades ago for manned aircraft. Usable strength-to-weight ratio and structural efficiency and reliability were then and are now critical design factors, along with the economic factors of cost, material utilization, and producibil-

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[4] Condensed from Paper No. 60—WA-316.

[5] Project Engineer, Research and Development, Wyman-Gordon Company, Worcester, Mass.

[6] Manager, Applications and Planning, Research and Development, Wyman-Gordon Company, Worcester, Mass.

Table 1 Tensile Properties of Forged Beryllium

Production parts Room temperature	90% of Parts[a]	Average
Ultimate, psi	48,000 to 60,000	53,000
Yield, 0.2% psi	34,000 to 46,000	40,000
Elongation	1.4 to 3.9	2.4

Development part Room temperature	Center[b]	Radial[b]	Tangential
Ultimate, psi	64,000	66,300	73,100
Yield, 0.2% psi	44,000	43,400	42,200
Elongation, %	4	7	10

[a] Highest and lowest 5% of values not included.
[b] Average of two tests.

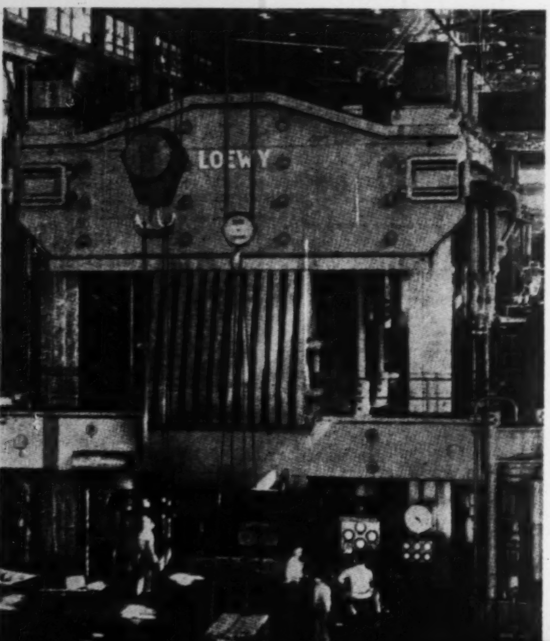
ity. Maximizing these factors is now even more critical to system performance and feasibility. In addition, operating environments have become more severe and varied, and requirements more complex, demanding a greater combination of properties and characteristics of materials. These conditions have necessitated an extension of materials technology into more complicated and sensitive alloys and metals. Greater control and refinement and new approaches are required in melting, working, and fabricating practices. Press forging is now not only used to improve the mechanical properties of these sensitive new materials such as B120VCA and Astroloy, but to consolidate from powder-form metals, such as beryllium, which cannot be readily worked in traditional cast-ingot form. The advantage of an integral component becomes more important as fabrication and joining processes become more difficult and critical, subtracting from the efficiency and reliability of the built-up structure.

Beryllium Forgings

Currently, nearly all beryllium components are produced starting with metal powder which is consolidated either by vacuum-press sintering into a block or by press forging into a shape. The powder approach has been practiced because beryllium cast ingots have not been readily workable. Sintered block has limited forgeability and is, of course, more expensive than powder so that its use in forging has been restricted to cases where forging design or economic advantage exist.

The beryllium powder process used by the writer's company differs from most conventional powder-metallurgy processes. High compacting pressures are used simultaneously within the range of the sintering temperatures, and the cycle time is very short. Plastic deformation or forging also occurs later in the cycle.

Fig. 5 The 50,000-ton press has a maximum daylight of 13 ft 9 in., a stroke of 5 ft 10 in., and a platen area of 12 x 32 ft



A specially designed metal container is loaded with beryllium powder, heated in a temperature range below 2000 F, and press forged in steel dies to the desired shape. Forging pressures are on the order of 75,000 psi. During the first part of the pressing stroke, the powder is compacted to full density with a decrease in the volume of canned powder of approximately 50 per cent. During the remainder of the stroke a controlled amount of plastic flow provides the best possible metallurgical structure and mechanical properties. The can material is removed by a chemical or mechanical operation and the beryllium forging is machined to produce the desired part. The three stages, illustrated in Fig. 9, are: (*a*) Canned beryllium powder, (*b*) canned beryllium forging, and (*c*) machined beryllium forging.

The container and die design determine, to the extent possible with a particular shape, the amount of reduction or plastic deformation which influences the degree of crystallographic directionality or texturing. "The crystallographic texture, which depends on the fabrication process, is fundamental to the development of mechanical qualities essential in airframe or missile application. The hot-upset technique for producing sheet can achieve the desired crystallographic texture and can impart excellent mechanical qualities with good process control, irrespective of sheet size. The hot-upset sheet was shown to be superior to beryllium sheet produced by other means in resisting the embrittling effect of size and complex stress. Its structural quality has been established in the box-beam tests in which it withstood the combined effects of "built-in" stress, stress concentrations, and static and dynamic loads at room and elevated temperatures without evidence of failure."[7]

Design criteria for structural applications have not as yet been well developed for beryllium.[7] Correlation of laboratory data and experience in structures are limited. Specifications have been controlling chemistry, density, and internal and surface defects, and specifying tensile properties, based on the capability of press-sintered block, of 40,000 psi ultimate, 30,000 psi 0.2 per cent yield, and 1 per cent elongation. Properties of formed parts are shape and direction-dependent. A range of tensile properties believed to be representative of *production* experience in forged parts of several configurations is presented in Table 1. Tests were made from integral test rings representing the *transverse* direction to plastic flow. Development work indicates the future possibility of improved property levels in production.

The "spread" of values between the stress for plastic flow and for fracture is being considered as possibly a more sensitive index of ductility or structural performance than elongation. This spread between the ultimate and yield strengths in forged material has been noted as being attractive. Although room-temperature strengths are higher for forged beryllium, at elevated temperatures of 1000 and 1500 F they are comparable to press-sintered material.

Hollow conical frustums, domes, guidance components, and pancakes have been forged successfully. Size of forgings has ranged from 1/2 to 300 lb, from (3 in. ϕ) 20 sq in. to (36 in. ϕ) 1000 sq in. in projected area. Forging capability exists beyond 4000 sq in. or 72 in. in ϕ. Photographs of beryllium parts are shown in Figs. 9 and 10. Large extrusions, weighing over 150 lb, have been made in development with limited success. More development is required. Parts have been forged successfully from press-sintered material, Fig. 10. Procedures have been developed for working it, without being canned, below 1500 F where rapid oxidation occurs.

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[7] C. J. Giemza, "Development and Evaluation of Structural Beryllium," WADC Technical Report 59-349, April, 1959, p. 58, conclusions 1, 2, and 8.

In hollow parts, material utilization (ratio of starting-material weight to rough-machined-part weight specified by the customer) is frequently as good as 2:1 and has been as low as 1.4:1. For blocks this is a 5:1 ratio.

Simple shapes of uniform thickness are the most readily producible. Irregular shapes generally can be produced by forging, with sufficient experience, from either powder or sintered block. Cost advantage of a forging depends on: (*a*) The starting material required; (*b*) material-utilization advantage in relation to other available forms; (*c*) the usefulness of improved properties in fabrication, machining, joining, and assembling processes resulting in lower scrap costs; and (*d*) the advantage of improved component properties in design.

Joining and fastening methods are critical problems in beryllium, particularly when considering reliability and efficiency. Large, integral component forgings offer a valuable design advantage.

At Grafton there is a completely integrated in-house production capability for producing beryllium forgings from receipt of powder to delivery of a completely tested, rough-machined component.

Beryllium applications are derived from the metal's outstanding physical, mechanical, and thermal properties and nuclear characteristics.[8] Potential usage includes structural components for aircraft, missiles, and space vehicles, re-entry shields, guidance components, aircraft brakes, compressor disks, rotor shafts, and nuclear-reactor components. The brittleness problem in beryllium is being overcome. It is believed that forged beryllium offers sufficient ductility to truly classify it as a structural material.

Titanium Forgings

At a yield strength of 180,000 psi the all-beta B120VCA (Ti-13V-11Cr-3Al) titanium alloy offers designers a material with a yield-strength-to-density ratio of 1,000,000 in. This strength level is equivalent to steel at 280,000 psi. Metastable B120VCA develops its high strength with ductility by an aging response after warm or cold-working. The prior deformation accelerates the aging reaction, and controls the nucleation and growth of the aging precipitate and helps to distribute it uniformly throughout the grain matrix rather than at the grain boundaries.

Two methods have been used to produce solid-rocket-motor casing, dome, and closures. In one method a billet is upset into a pancake which is drawn through a draw ring to produce the dome. In a second method the dome is closed-die forged.

The forging designs provide material for integral igniter and thrust-termination bosses and attachment skirts, eliminating or extending welds from highly stressed areas. Working temperatures are as low as possible, in the 1800 to 1000-F range, and the number of

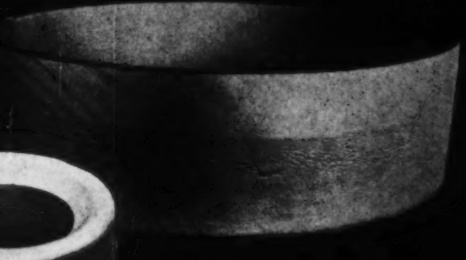

Fig. 6 Forward closure, approximately 40 in. diam

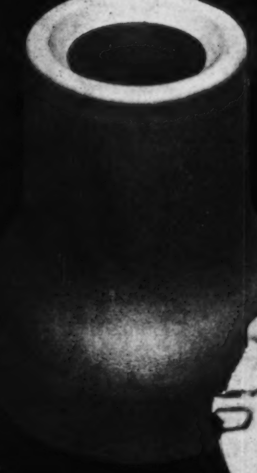

Fig. 7 Rocket nozzle, 12 in. diam x 16 in. high, weighing 80 lb, forged on the USAF presses

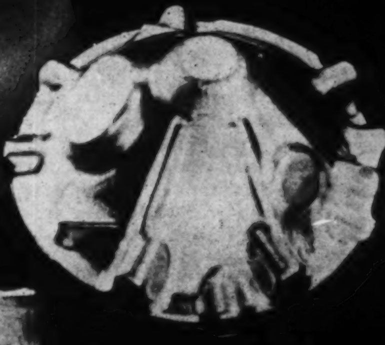

Fig. 8 A sustainer thrust cone, 26 in. diam x 10 in. high, forged of aluminum 7075

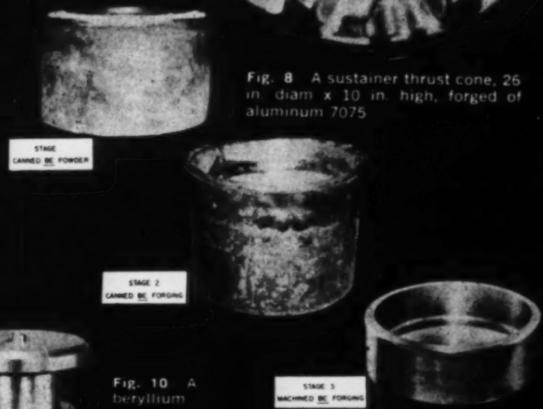

Fig. 9 Three stages in the beryllium-powder forging process, left to right, are: **(a)** Canned beryllium powder, **(b)** canned beryllium forging, and **(c)** machined beryllium forging. The forging is 10 in. diam x 3 in. high.

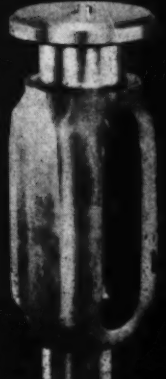

Fig. 10 A beryllium guidance component successfully forged from press-sintered material in the forging program sponsored by the U.S. Army Ordnance Corps

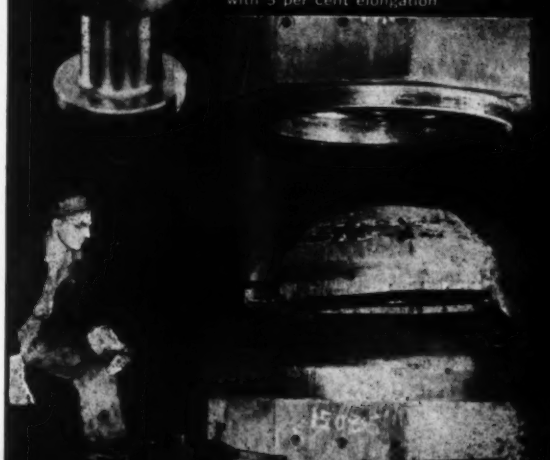

Fig. 11 A 38-in-diam end closure, an elliptical dome forged of B120VCA, met the initial target of 180,000 psi yield with 5 per cent elongation

operations or reheats are held to a minimum. B120VCA has shown very good forgeability. Aging following forging is done at approximately 900 F for time periods as required. With these methods, press-forging capability for property response exists above 54 in. diam.

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[8] W. Hodge, "Beryllium for Structural Applications—A Review of the Unclassified Literature," Defense Metals Information Center, Report 106, Battelle Memorial Institute, Columbus, Ohio.

End closures have been produced up to approximately 38 in. diam, Fig. 11, meeting the initial target of 180,000-psi yield with 5 per cent elongation. The forging customer has machined and welded these closures into full-scale motor casings which have met all design objectives in burst testing.[9]

Continued development work with B120VCA in domes offers growth potential in yield strengths up to 200,000 psi with elongation of up to 5 per cent. Work is also being conducted in other areas to demonstrate property response in irregular shapes and in heavy sections. Another development is the extrusion of B120VCA into a 25-in-long × 5.8-in-diam tube. Results of this effort indicate that scale-up to much larger diameters is feasible.

Titanium 6Al-4V has been used extensively in pressure bottles for liquid-rocket-engine systems. In one very successful fabrication approach, machined hemispheres with integral bosses are pressure welded together to produce spherical bottles.

Nickel-Base-Alloy Forgings

The nickel-base superalloys are the ranking alloys between 1200 and 1800 F for short-time tensile strength and for long-time creep-rupture strength. Waspaloy, René 41, Udimet 500, and Astroloy were developed for aircraft gas-turbine components, usually first for use in buckets and then in wheels.

The first major missile application has been for turbine wheels in turbopumps for liquid rocket engines. René 41 forgings up to 44 in. diam and 950 lb have been produced to the guaranteed properties, shown in Table 2.

These alloys develop their high-temperature strength from age-hardening by general precipitation of the Ni_3 (Al, Ti) phase following solution treatment. Forging-temperature range, and the rate and amount of deformation are critical in addition to proper heat-treatment for the development of properties. Full property response has been found to be influenced by prior work.

As the aluminum and titanium contents are increased to increase strength, as in Astroloy, the alloy becomes more sensitive to melting and processing practices. The advanced alloys have been found to be strain-rate sensitive where tendency toward cracking increases directly with forging rate.

The nickel-base-alloy forgings have been developed as a group by the writer's company through a total effort involving induction vacuum melting, casting, forging, and heat-treatment studies. Present level of capability is best summarized with photographs of typical wheel and shaft forgings, Fig. 12, and with a statement of guaranteed minimum properties in Table 2. Continuing work is concerned with the forging of these alloys in structural shapes for use in manned aircraft and vehicles, and the design and forging development of advanced alloys. Forgings beyond the present 50-in-diam property-guarantee limit are being proposed up to 100-in. diam. In this size range material availability becomes a primary problem.

Refractory Metal Forgings

This group of metals includes tungsten, tantalum, molybdenum, and columbium in order of melting points and therefore potential usefulness for temperature applications above 1800 F in advanced propulsion units and vehicles. Molybdenum forgings for solid rocket motors, Fig. 14, are in production on small equipment. Tantalum and tantalum-tungsten alloys have been forged on a development basis. Very limited work has been done with tungsten although the effort is increasing with the definition of new approaches.

Columbium—1 per cent Zr forgings are being successfully produced as large as 36 in. diam and weighing up to 1300 lb. Ingots are produced by vacuum consumable-electrode melting of electron-beam-melted columbium. They are converted, by upsetting, into pancakes which are forged into a blocker shape and then into a finished shape. Forging temperature has been 2250 F. The material in forging has been characterized as ductile but stiff. The problem of gas contamination during heating, the resulting surface cracking during forging, and the development of proper coatings are discussed later.

Steel Forgings

Steel is a material with extensive metallurgical and production experience, high strength at relatively low cost, and great flexibility in heat-treatment.

The major use in missiles has been for solid-rocket-motor casings where strength-to-weight ratio, fracture toughness, and fabricability are the primary criteria for materials selection. Closures pictured in Fig. 15 are

Table 2 Minimum Properties in Nickel-Base-Alloy Forgings[a]

	Tensile properties					Stress rupture			
Alloy	Test temp, deg F	Heat treat[c]	Ultimate strength, psi	0.2% Yield strength, psi	Elong, per cent in 2 in.	Temp, deg F	Stress, psi	Life hours	Elong, %
Waspaloy[b]	RT	A	175,000	120,000	12	1350	65,000	90	8
	1200	A	155,000	105,000	20				
René 41[b]	RT	B	180,000	130,000	12	1650	25,000	25	10
	1400	B	135,000	110,000	13				
Astroloy[b]	RT	C	190,000	138,000	8	1800	20,000	25	7
	1400	C	150,000	122,000	10				
Udimet 500[b]	RT	D	175,000	120,000	10	1650	25,000	35	10
	1400	D	125,000	105,000	12				

[a] Guranteed minimum properties apply in radial and tangential directions to wheels and disks up to 50-in. diam except 40-in. diam for Astroloy.

[b] Waspaloy—Pratt & Whitney Aircraft Corp.; René 41 and Astroloy—General Electric Company ; Udimet 500—Metals Division Kelsey-Hayes Company.

[c] Heat-Treatment:

A 1850 F—4 hr—OQ; 1550 F—2 hr—AC; 1400 F—16 hr—AC

B 1950 F—4 hr—AC; 1400 F—16 hr—AC

C 2100 F—1/2 hr—AC; 1400 F—16 hr—AC

D 1975 F—4 hr—AC; 1550 F—24 hr—AC; 1400 F—16 hr—AC being forged in vacuum-melted, low-alloy steels such as H-11, 300-M, and D-6C.

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[9] N. G. Orrell and J. E. Coyne, "High Strength and Good Ductility Attained in Full-Size B12OVCA Forgings," article to be published.

These forgings exceed the present specification requirements for minimum 0.2 per cent yield strengths of 220,000 to 230,000 psi with 8 per cent elongation. The design philosophy of integral bosses and attachment skirts originated with the steel casings.

Large structural steel forgings, such as frames and pylons which may be applicable to advanced vehicles, are shown in Fig. 16. The largest is SAE 4335, 98 in. long, weighing approximately 1100 lb. A 17-4 PH semiaustenitic stainless-steel U-shaped frame 44 in. wide × 32 in. high is being produced. Another type of forging experience is with components for the nuclear power industry. Fig. 17 shows an AM355 forging weighing over 2000 lb. Typical tangential properties of test specimens taken from the heat-treated forging are 179,000 psi ultimate, 150,000 psi 0.2 per cent yield, and 15 per cent elongation. Short transverse ductility is 3 per cent.

Aluminum, Magnesium, and Copper Forgings

Previous papers[10,11] have sufficiently defined capability with these materials.

Forging Processes

Forging is combined with other operations to produce the finished component with the desired properties, configuration, tolerances, and surface condition. Traditionally this final process has been machining or grinding, but electrochemical milling and electrostatic discharge machining are being used. Roll-forming which produces surfaces of revolution, extruding, and drawing are effective processes in certain geometries for redistributing a portion or all of the material in a forging preform into a semifinal or final form. Machining is minimized and material utilization is maximized. The effective marriage of forging with these other complementary processes is in progress although the effort needs to be expanded.

Extrusion and drawing have received attention at Grafton. Hot vertical extrusions of aluminum, steel, titanium, and beryllium have been made in the forging presses. Diameters up to 65 in. are presently being considered. Daylight and stroke of the press limit extrusion length. Drawing of sheet or a forged preform are being studied. Consideration has been given to auxiliary hold-down cylinders and to a rubber forming unit that could handle blanks up to 148 in. diam.

The powder-metallurgy process permits the production of engineering materials which cannot be practically produced by other metallurgical processes. Beryllium has been used initially at Grafton, but composite materials such as metal-metal mixtures, metal-oxide mixtures, metal-nonmetal mixtures, and metal-fiber mixtures are other possibilities.

The process of closed-die forging needs and is receiving attention in the process-development programs. These programs are concerned with improved methods of die sinking and material heating, better die materials, better lubricants, and better material coatings.[12]

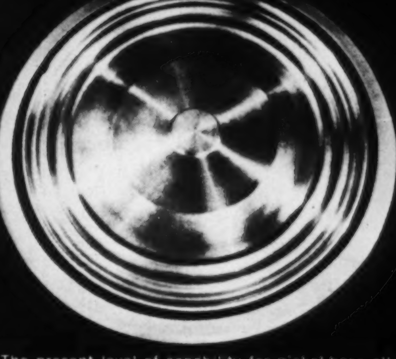

Fig. 12 The present level of capability for nickel-base alloy forgings is illustrated by a 26-in-diam, 170-lb Astroloy turbine-wheel forging and integral ring

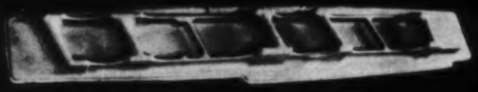

Fig. 13 Outboard pylon support, 99 x 10 in., weighing 1150 lb

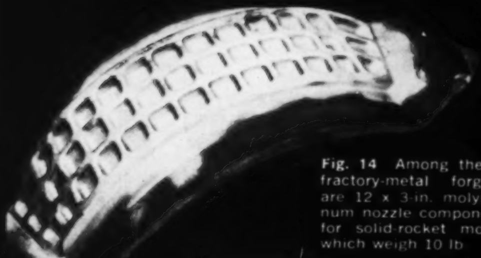

Fig. 14 Among the refractory-metal forgings are 12 x 3-in. molybdenum nozzle components for solid-rocket motors which weigh 10 lb

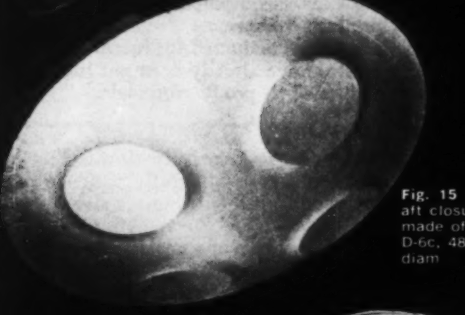

Fig. 15 An aft closure made of steel D-6c, 48-in. diam

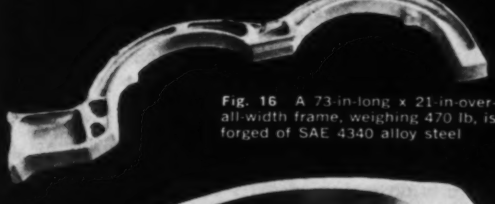

Fig. 16 A 73-in-long x 21-in-overall-width frame, weighing 470 lb, is forged of SAE 4340 alloy steel

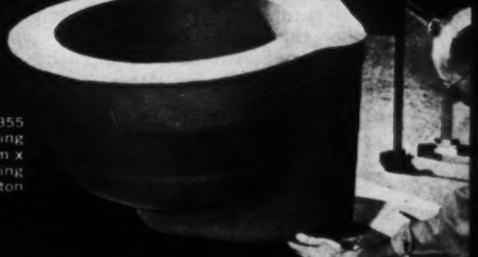

Fig. 17 An AM355 stainless-steel fueling head, 30 in. diam x 20 in. high, weighing over a ton

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[10] "Symposium on Heavy Presses for Light-Metal Forgings and Extrusions," *Trans. ASME*, vol. 75, November, 1953, pp. 1481–1542.

[11] G. W. Motherwell, "Heavy Presses Now in Production," MECHANICAL ENGINEERING, vol. 78, March, 1956, pp. 214–217.

[12] In the original paper, available in preprint form, the author devotes several pages to research on lubricants and coatings.

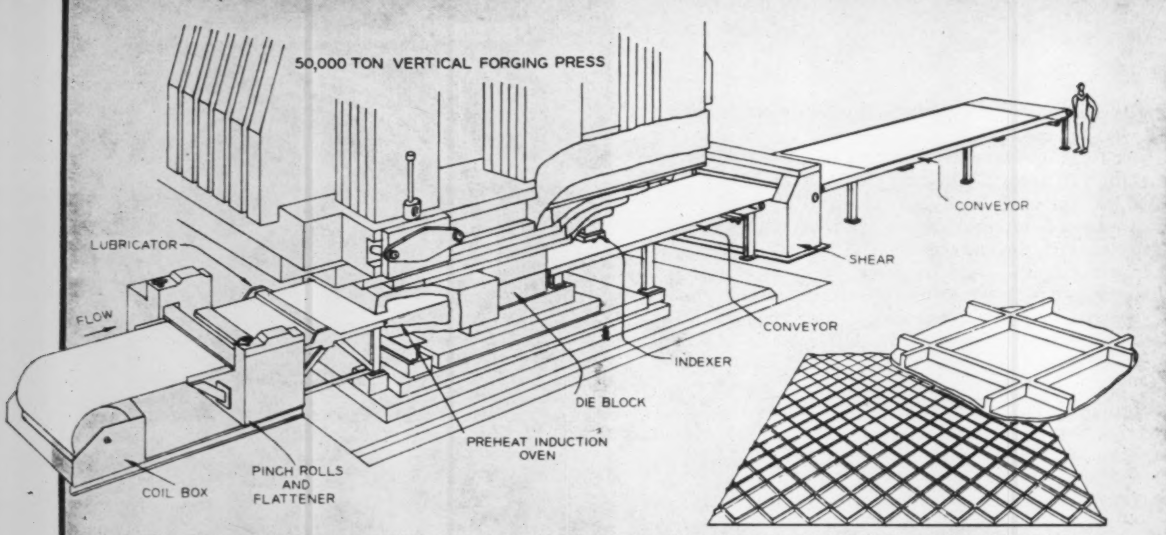

Fig. 18 A continuous-belt production line for making integrally stiffened panels with a wafflelike configuration. Engineering studies have proved the feasibility of installing this system on a 50,000-ton press. No press modifications are necessary and the entire set-up can be removed for conventional forging.

By Jacob Brayman[14]

ASPECTS OF HEAVY PRESS UTILIZATION[13]

It became apparent early in the Heavy Press Program that the capabilities and scope of the presses could be greatly expanded to cover a wide range of materials and configurations by the addition of relatively inexpensive auxiliary tooling and/or equipment, such as mechanical handling and heating auxiliaries.

Several of the studies conducted for increasing the usefulness of the presses have already been put into practice on either a limited or a full-production scale.

Integrally Stiffened Panels

The use of raised ribs on relatively thin panels (commonly called waffle plates or integrally stiffened plates) increases rigidity many times with only a slight increase in weight.

An integrally stiffened skin of a missile has been milled from a solid plate. Original attempts to produce this item by chem-milling were abandoned because of the heavy weight penalty inherent in that process. However, the mechanically milled panel also shows a heavier weight than the theoretical configuration should and also a high reject rate. A development program was undertaken to prove that the use of heavy presses in the manufacture of this item will offer substantial advantages.

The forged sample panels produced in a joint venture with the Wyman-Gordon Company proved that: (*a*) There is no weight penalty with the forged panel; (*b*) it is entirely feasible to produce panels from materials other than aluminum alloy; (*c*) simple and relatively inexpensive auxiliary equipment would permit the production of very large panels, eliminating many joints and fasteners.

A continuous-belt production-line setup is used for forging the panels on the 50,000-ton vertical forging press. Raw stock is fed from a continuous coil through pinch rolls and a flattener, through a preheat oven, and finally through the die block where it is formed. Since this is a continuous operation, an indexing method is used to position the sheet precisely so that the formed pattern is continuous and no discontinuity is present. The panels are then run through a shear which will cut them to any length and finally onto a conveyer, Fig. 18.

Engineering studies have proved the feasibility of installing this system on the 50,000-ton press. It also should be pointed out that no modification of the press itself is required and the entire apparatus may be removed at any time to permit use of conventional forging.

Deep-Drawing Rubber Pads

The possibility of using rubber pads for deep drawing on large presses was pointed out as early as December, 1951. A rubber-pad unit has been designed which, when installed on a 50,000-ton press, will allow the use of a blank of about 140 in. diam and depth of draw of up to 48 in. in thin sheet and in heavy plate as well. Such a unit would allow the production of large missile cones, spherical or rectangular fuel and gas tanks, and the like. It also could be used for the manufacture of cylindrical configurations for jet-engine separator rings. A general arrangement of a rubber-pad, deep-draw unit utilizing the full capacity of the 50,000-ton press is shown in Fig. 19. The upper housing contains layers of rubber pads while the bottom housing contains the holdback draw system. In order to effect a deep draw without wrinkling the drawn sheet, a variable holdback pressure must be used with the holdback pressure at any point being dependent on the amount of metal required to form the surface. Incorporated in this unit is an automatic program-control apparatus which is preset in advance of the draw. Also shown on the bed of the press is a hydraulic system reservoir making the entire deep-draw apparatus independent of the press hydraulic system. The apparatus then requires no modification to the press and can be removed when conventional forging is required.

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[13] Condensed from Paper No. 60—WA-317.

[14] Senior Development Engineer, Engineering Supervision Company, New York, N. Y.

It is important to note that, in all of the configurations, when it is desired to keep the cross-sectional thickness of the drawn shape constant, it can be done on the deep-draw unit. Also, by proper programming of the holdback system, a variable cross-sectional thickness may be obtained. These shapes, at the present time, may be drawn of thickness up to $1^1/_2$ in.

Right-Angle Forging Equipment

An interesting variation of the rubber-pad process is the use of the right-angle forging arrangement. In this arrangement, the rubber pad consists of a cylinder and is placed internally within the sheet to be formed. An arrangement which has been proposed for the forging of jet-engine separator rings is shown in Fig. 20. The cylindrical arrangement requires a split male die to effect removal of the formed part.

Large Wide Flat Panels

The wider use of extrusion presses for producing large flat panels as well as for various end items has been explored and confirmed. Their use in extruding very wide flat shapes is shown in Fig. 21. Rectangular containers can be used to do these jobs and require less extrusion pressure when properly designed than conventional.

Sandwich and Honeycomb Structures

Larger sandwich and honeycomb configurations are possible. These panels have been used to form a lightweight high-strength sandwich configuration and also as a single panel to form a missile cylinder. In order to utilize the benefits of this panel fully, it must be produced in relatively large quantities.

Tank Hull Components

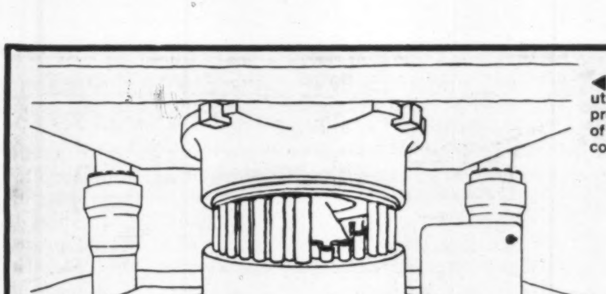
The producibility of major components of tanks (M48 and T95) by closed-die forging on heavy presses has been investigated. These parts are at present being cast. However, a study has indicated that a great deal of lead time may be eliminated by the use of the heavy presses.

Several tank hull components that are presently being cast can be forged to shape and prepared for welding.

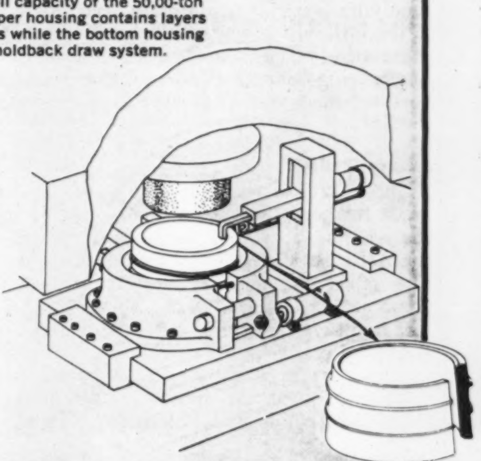
Conclusions

As the physical, thermal, fatigue, creep, and constructural requirements for missiles, space vehicles, and weapons systems continue to mount daily, the use of new high-strength alloys and materials in structural and operating members becomes inevitable. The Mach 3 generation of fighters, bombers, and the still more advanced weapons systems imposed significant changes in the conventional materials used in their production and on the general configuration of airframe construction in order to cope with the environmental characteristics of hypersonic and nonair-supported flight. Furthermore, the transition from manned aircraft to missile systems introduces important changes in methods of fabrication as well as completely new requirements. Deep drawing of large nose cones, large venturi nozzles (to name only a few examples) in some of the materials being actively considered at present (titanium alloys, high-strength aluminum alloys, hot-work tool steels, precipitation-hardening semiaustenitic stainless steel, and, lately, beryllium, molybdenum, and tungsten) require new advanced production thinking.

These new materials exhibit the required properties of high strength at high temperatures so necessary for future aircraft and missiles. At the same time, they pose new manufacturing problems. The adaptation of the heavy-press fabrication techniques to these materials and configurations is a definite necessity if progress in the materials-fabrication field is to continue.

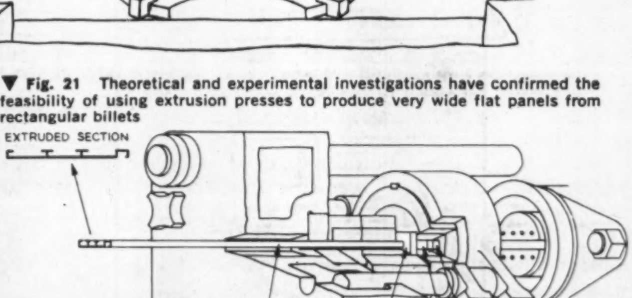


◀**Fig. 19** A rubber-pad deep-draw unit utilizes the full capacity of the 50,00-ton press. The upper housing contains layers of rubber pads while the bottom housing contains the holdback draw system.



▲ **Fig. 20** Right-angle forging equipment is a variation of the rubber-pad process. The rubber pad is cylindrical in form. It expands internally within the ring forging when under pressure.

▼ **Fig. 21** Theoretical and experimental investigations have confirmed the feasibility of using extrusion presses to produce very wide flat panels from rectangular billets



MACHINE DESIGN
Geology of Petroleum
A TREATISE ON APPLIED HYDRAULICS
RADIANT HEATING
VAN DOREN
INDUSTRIAL DESIGN
EXPERIMENTAL STRESS ANALYSIS

The library, collector of the world's engineering literature, moves to the new United Engineering

The Engineering Societies

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By Ralph H. Phelps, Director, Engineering Societies Library, New York, N. Y.

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per cent of the total income. Most of the other 42 per cent came from charges for service, with small amounts from endowments, royalties, and contributions from other societies.

Last year on 6334 orders, the ESL supplied 87,500 photoprints—up 23 per cent

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168 literature searches—up 29 per cent
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2270 books loaned to members—up 13 per cent
24,700 telephone inquiries—up 36 per cent

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Center. Supported by more engineering societies, it will cover more fields in greater depth

Library **on the Move**

All these services, except the loan of books, are available to anyone, and engineers, scientists, technologists, and people in industry from all over the world take advantage of them.

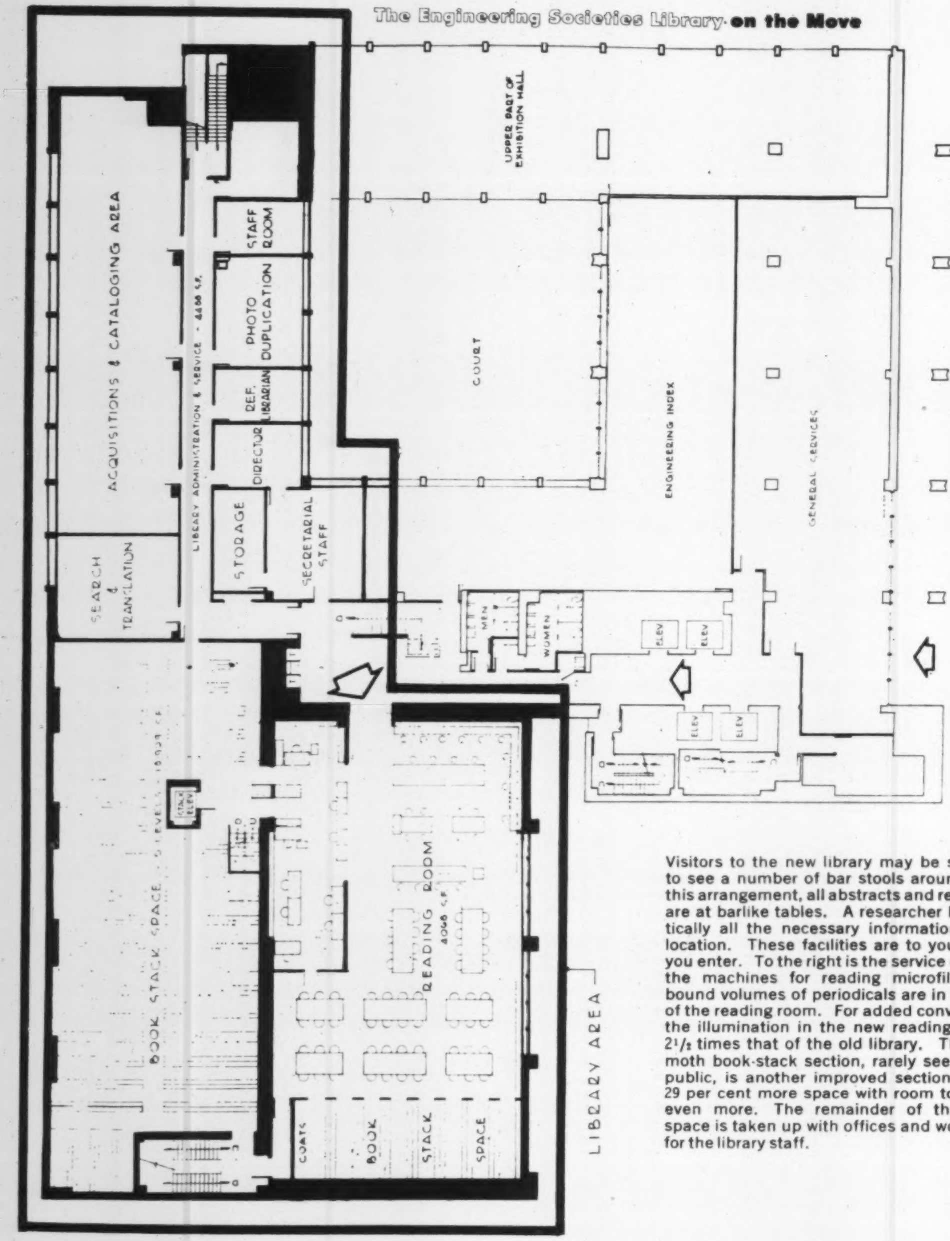
The location of the library offers an opportunity to be of service to the United Nations. The UN's expanding interest into problems of technical assistance, peaceful use of atomic energy, and the exploration of outer space will call for more research facilities in engineering and the other sciences. The UN's library is not planning to extend its scope into these areas but will arrange with specialist libraries, such as the ESL, to provide such service.

Ever Growing

The ESL becomes busier every year. There was a 14 per cent increase in the use of the library over last year. Nonvisitor use of the library by mail, telephone, and telegraph increased 26 per cent, making an increase of 176 per cent in the past 10 years. Of the 60,000 served, 68 per cent did not visit the library. A sampling of last year's correspondence shows users in 31 foreign countries and in 47 of our 50 states.

Income from the paid services of the ESL increased over 40 per cent. Last year the Founder Societies' direct contribution to the library amounted to about 58

To . . . the wing of the building on the right▶ of the main tower goes the new Engineering Societies Library, with its convenient second-floor location. The row of windows above the trailer is part of the library work space.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READING ROOM 4000 S.F.
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LIBRARY AREA

Visitors to the new library may be surprised to see a number of bar stools around. With this arrangement, all abstracts and references are at barlike tables. A researcher has practically all the necessary information in one location. These facilities are to your left as you enter. To the right is the service desk and the machines for reading microfilm. The bound volumes of periodicals are in the back of the reading room. For added convenience, the illumination in the new reading room is 2½ times that of the old library. The mammoth book-stack section, rarely seen by the public, is another improved section. It has 29 per cent more space with room to expand even more. The remainder of the library space is taken up with offices and work areas for the library staff.

All publications received and retained by the ESL are available to the staff of The Engineering Index, Inc. From these publications 33,000 articles and other items were indexed in 1960. Each reference is annotated and all are published in a daily card service and subsequently in a cumulated annual bound volume. The original articles for everything listed in The Engineering Index are kept by the library. Photoprint or microfilm copies of this material are available.

In the Future

There was a time when an engineer might have in his head and handbooks most of the information he might need. Today that is seldom possible. Information can in many cases be found only through literature research. No library can claim to be able to meet all needs, but many can be satisfied through the ESL.

The statistics show a rapid growth in the use of ESL's facilities indicating the growing awareness of its value to the engineering profession. With more engineering societies joining together in the United Engineering Center in acting support of the ESL, it will be of increasing service to the engineering societies and the profession.

ULTRAHIGH STRENGTH MATERIALS of the Future

By John J. Gilman[1]

We are now on the verge of a revolution in which strength of materials will increase into the million-psi range. What will the materials be like, and how will we employ them?

There are good reasons to suppose that strong engineering materials of the future will have the form of monocrystals, will be brittle, and will be composed of interstitial compounds of the transition metals or of covalent compounds of the light elements. Various compounds of carbon appear to be especially attractive.

The discussion which follows is based primarily on what is known about the elastic moduli of various crystals. Elastic stiffness measures the strengths of interatomic bonds and increases very rapidly with decreasing interatomic spacing for nearly all crystals. Since crystalline packing of atoms minimizes interatomic distances, it is concluded that maximum strength requires monocrystalline form. Very strong crystals will necessarily be brittle because ductility is incompatible with strength that is significantly greater than that of currently available steels. Interstitial and covalent compounds are attractive because they have the highest elastic moduli of all crystals, and because dislocations are immobile in them.

Certain mechanical devices such as high-pressure vessels, ultracentrifuges, cutting tools, and flywheels are absolutely limited in their performance by the strength of available materials. Hence they would realize unique benefits from the materials discussed here. Aircraft and missiles would also benefit through improved *relative* performance.

Simple machine elements (rings loaded in tension) were constructed from silicon monocrystals in order to demonstrate the feasibility of the ideas that are presented. Only commercially available material and machining were used. The rings supported stresses up to ~500,000 psi before fracturing, or loads ~200,000 times their own weight.

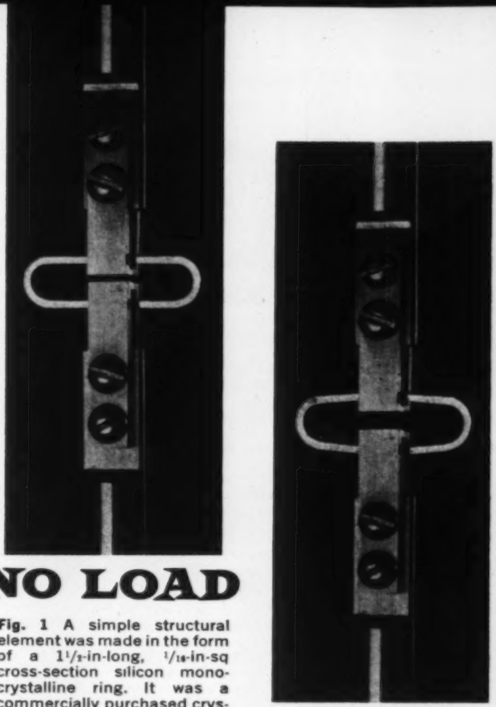
When steel became an inexpensive article of commerce in the 1860's, it was an order of magnitude stronger than anything else that was available (150,000 psi compared to 15,000 psi for wrought iron). It is not surprising that it revolutionized every industry that it touched.

The Problem

The first problem that must be considered is how to proceed. What chemical composition and what internal structure should an ultrahigh-strength material have? What manufacturing and design difficulties can be expected to arise? What might such a material be used for? Sensible, although perhaps not final, answers to these questions can be obtained from modern knowledge of the mechanical behavior of solids and some guesses.

The simplest property of a solid that characterizes its strength is its elastic modulus—the stress that is required to stretch its atoms apart; or, in other words, the strength of its interatomic bonds. When the atomic bonds have been stretched 5 to 10 per cent they are no longer able to exert attractive forces between the atoms, and rupture occurs. As a first approximation, the ultimate strength of a solid equals 5 to 10 per cent of its elastic modulus. This is not the strength that is usually observed in practice. It is the extreme upper limit that can be observed under ideal conditions.

In practice, the strength of a solid is often determined



NO LOAD

500,000

pounds per square inch

Fig. 1 A simple structural element was made in the form of a $1^1/_2$-in-long, $^1/_{16}$-in-sq cross-section silicon monocrystalline ring. It was a commercially purchased crystal, but chemically polished to remove all scratches. **Left,** with no load, and, **at right,** just prior to fracture.

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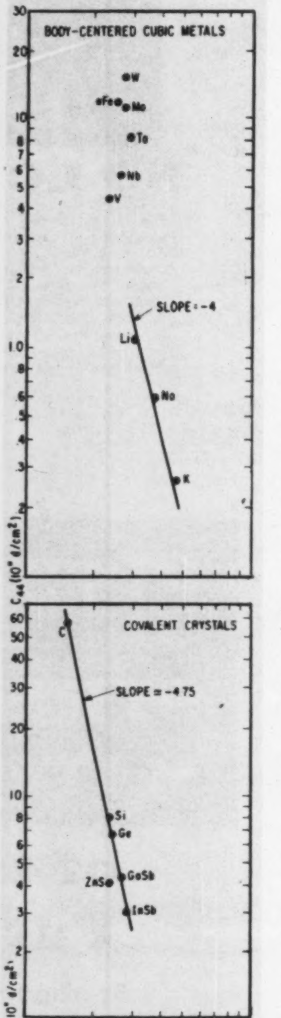

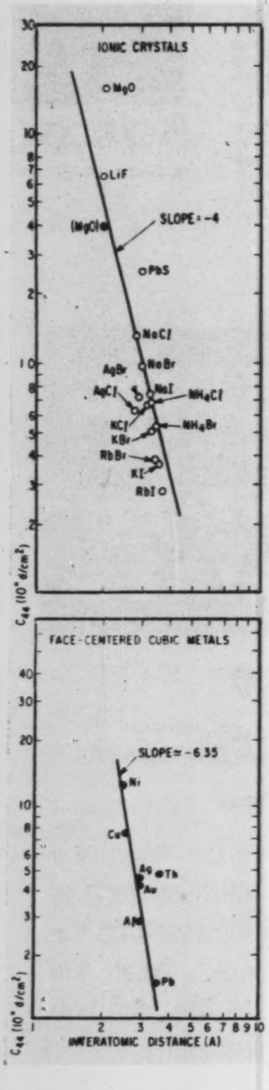

Fig. 2 The elastic moduli of atomic bonds depend on interatomic distances. For truly ionic crystals, such as the sodium and potassium halides, the elastic shear moduli are proportional to the inverse fourth power of the distance between particles. The moduli of other crystals are also very dependent on interatomic distances with the exception of the transition metals, where the electronic structure (or valence) of the atoms plays a more important role. MgO illustrates the importance of valence. The open circle is plotted at the actual value of the elastic modulus while the solid circle is plotted at ¼ of this value to correct for the divalence of the ions in MgO. In accordance with the idea that MgO is bound together by electrostatic forces, the corrected value lies near the curve for monovalent ionic crystals.

by the motion of dislocations within it (plastic yielding), or by the fact that it contains small cracks that can be opened up by relatively small stresses. The metal iridium has an elastic modulus that is among the highest known values (80 million psi), yet iridium has only modest strength because it flows plastically at a stress 1000 times smaller than its elastic modulus. Likewise, an extremely hard material like silicon carbide has a very high elastic modulus (70 million psi), but is ordinarily quite weak because it contains cracks.

In designing a strategy for obtaining high strength, the factors that determine the strengths of atomic bonds are measured by their elastic moduli and must be considered first. Electrostatic forces of attraction are the primary cause of all atomic binding. These forces are inversely proportional to the square of the distance between charged particles; and, since the distance between atoms approximately equals their size, the electrostatic *stress* becomes inversely proportional to the fourth power of the interatomic distance. This puts a premium on having small tightly packed atoms in a material in order to achieve high strength.

Chemical valence is also an important factor because it determines the attraction between atoms of a particular size. For a fixed distance between atoms, the force between them increases in proportion to the product of the charges on the atoms.

The sensitive dependence of the elastic moduli of atomic bonds on interatomic distances is shown in Fig. 2.[2] For truly ionic crystals, such as the sodium and potassium halides, the elastic shear moduli are proportional to the inverse fourth power of the distance between particles. The moduli of other crystals are also very dependent on interatomic distances with the exception of those of the transition metals. With these, the electronic structure (or valence) of the atoms plays a more important role.

Internal Structure for Ultrahigh Strength

The general type of solid that is required for ultrahigh strength is crystalline because the atoms in crystals are more tightly packed than in glasses or in high polymers. The material cannot contain gross defects such as voids, cracks, or foreign inclusions. It probably cannot contain the less severe defect of grain boundaries either, because the best available evidence indicates that the strengths of materials containing grain boundaries do not exceed about 200,000 psi.[3] This may be contrasted with strengths up to 2,000,000 psi that have been observed for monocrystals.

Defects that are still less severe than grain boundaries are dislocations and atomic vacancies. If these defects

Table 1 Comparison of the Melting Points, in Deg C, of the Borides, Carbides, and Nitrides of Some Metals

Metal	B	C	N
Ti	2020[a]	3250	2950
V	2250	2830	2030
Ta	2420	3875	3100

[a] Decomposes

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[2] Most of the data came from H. B. Huntington, "Solid-State Physics," vol. 7.

[3] Another factor of two or so can be obtained by producing a fibrous structure in a polycrystalline material, but this simply places a major fraction of the grain boundaries parallel to the principal applied tensile stress, leaving the material quite weak in the transverse direction.

can move around in a material, or if they are present in high concentration, they cause a substantial loss of strength. However, if they are few in number and immobile they can probably be tolerated, so it might not be essential to use absolutely perfect monocrystals.

A structure that has often been suggested and discussed in recent years is that of a composite consisting of a bundle of very fine whiskerlike crystals embedded in a polycrystalline or glassy matrix. There have been many observations that crystals in whisker form have very high strength, and the hope is that this strength can be exploited in a composite.

The writer has no confidence in this approach. It might be useful in very special situations, but it poses serious difficulties. First, and perhaps easiest to overcome, is the problem of obtaining a high packing fraction for small fibers through an economic process that does not spoil their high strength. Another serious difficulty is that, if the matrix is softer than the reinforcement fibers, stress concentrations will inevitably arise when the material is stressed and these are likely to lead to fracture. If the matrix has a hardness similar to or greater than the fibers, there is little point in putting fibers into the matrix. A third difficulty is that of forming strong interfaces between the matrix and the fibers. The interfaces can be expected to behave no better than grain boundaries.

It is the author's conclusion that ultrastrong materials will take the form of monocrystals. The monocrystals will be structurally sound and have very high elastic moduli. Defects with no more than atomic dimensions (dislocations) can probably be tolerated in them.

Chemical Composition for Ultrahigh Strength

The stability or strength of a crystal generally can be estimated from its melting point or hardness. Although the elastic modulus is a better criterion of strength, measured values of it are often not available, and theoretical values are unreliable. Chemical stability in molecules is no guide to strength in crystals because stable molecules often form weakly bonded crystals.

Some metals that form strongly bonded crystals (for example, W, Ir, Ru), flow plastically with ease, and are unattractive for ultrahigh strength. However, their crystal lattices can be strengthened by putting small atoms (such as B, C, and N) in the interstices between the metal atoms. This not only raises the elastic moduli of the crystals, but also increases their hardness by making it difficult for plastic flow to occur. Carbon seems to have the most effect as an interstitial atom. The melting points of the borides, carbides, and nitrides of Ti, V, and Ta are shown in Table 1. In each case the melting point (a measure of strength if other factors are constant) is highest for the carbide.

Table 2 Effect of Carbide Formation on the Bond Strength of Various Metals

	Elastic modulus, million psi			Elastic modulus, million psi	
	Metal	Carbide		Metal	Carbide
W	60	100	Nb	23	50
B	50	65	Si	23	70
Ta	27	43	Ti	16	45
V	24	40	Zr	10	50

References: W. Koster, *Zeitschrift für Metallkunde*, vol. 39, p. 1, 1949; R. Kieffer and P. Schwarzkopf, "Hartstoffe und Hartmetalle," Springer-Verlag, Vienna, Austria, 1953.

The effect of adding carbon on the elastic moduli of various metals is shown in Table 2. The strength improvement on the average is more than a factor of two. It can be concluded that the ultimate in strength will not be obtained using pure metals, but will require compounds. Whether simple metallic carbides are the most strongly bonded of all crystals is not known at present. There are some indications that mixed carbides, carboborides, or carbonitrides might be stronger. Carbon carbide (diamond) is the hardest material that is known, but its ultimate strength in tension might not be as great as that of some anisotropic crystals. An extreme example is graphite which has a higher elastic modulus than diamond in the direction parallel to the graphite layers but is weak in the direction perpendicular to its layers. Hexagonal SiC or TiB_2 are useful examples.

On the basis of existing observations in special cases, strengths up to 5 per cent of the elastic modulus of a crystal seem reasonable to expect, Table 3. Although there is considerable scatter in the data, $E/20$ has been achieved in some cases but not often exceeded. The temperature at which strength is measured is an important variable, of course, because the nucleation of a crack is aided by temperature. Thus strengths greater than $E/20$ might be obtained at low temperatures.

In some crystals, dislocations will be mobile at high stress levels, and this will cause failure due to shear stresses rather than tensile stresses. Failure by shear will occur at some fraction of the shear modulus, so such crystals will be less strong than crystals in which dislocations are immobile. There are two reasons for this. One is that the shear modulus is usually somewhat less than half the Young's modulus. The second is that theory indicates that the nucleation of a dislocation loop will occur at a stress that is about one fifth as great as the stress required to nucleate a crack.

Crystals that hold the most promise as ultrastrong materials are listed in Table 4. Only those with known elastic moduli are considered, so many materials have been overlooked. The various crystals are ranked on the basis of their absolute strength (5 per cent of E), and on the basis of their anticipated strength-to-weight ratios (Young's modulus divided by density).

Table 3 Highest Strengths Attained by Various Forms of Solids

Material	σ_f = Maximum observed strength, million psi	E, million psi	E/σ_f
Music wire[a]	0.4	20	72
Silica fibers[b]	3.5	14	4
Iron whisker[c]	1.9	43	23
Al_2O_3 whisker[c]	2.2	72	33
NaCl[d]	0.16	6.3	40
Silicon whisker[e]	0.94	24	26
Mica[f]	0.43	...	...
Silicon (bulk)[g]	0.75	24	32
Boron[h]	0.35	51	145
Austformed steel[i]	0.45	29	64

[a] NBS Circular C447, U. S. Government Printing Office, 1943.

[b] F. O. Anderegg, *Industrial and Engineering Chemistry*, vol. 31, 1939, p. 290.

[c] S. S. Brenner, "Growth and Perfection of Crystals," John Wiley & Sons, Inc., New York, N. Y., 1958, p. 157.

[d] Z. Gyulai, *Zeitschrift für Physik*, vol. 138, 1954, p. 317.

[e] C. C. Evans, reported by J. E. Gordon, in (c), p. 219.

[f] E. Orowan, *Zeitschrift für Physik*, vol. 82, 1933, p. 235.

[g] G. L. Pearson, W. T. Read, and W. L. Feldman, *Acta Metallurgica*, vol. 5, 1957, p. 181.

[h] C. P. Talley, *Journal of Applied Physics*, vol. 30, 1959, p. 1144.

[i] J. C. Shine, V. F. Zackay, and D. J. Schmatz, ASM Preprint No. 163, 1959.

ULTRAHIGH STRENGTH MATERIALS

From the standpoint of absolute strength, some of the transition-metal carbides like WC and TiC appear superior to nonmetallic crystals. However, because of the small masses of their atoms the nonmetallic crystals have better strength-to-weight ratios. Among the more or less isotropic crystals, diamond is the king from both the standpoint of absolute strength and strength-to-weight. Things like cubic BN, TiB_2, SiC, B_4C, and B also look very good. If strength in only two dimensions is considered, graphite is outstanding.

The small size and relatively high valence of carbon atoms give diamond its high strength, and one whole group of high-strength crystals is formed from various combinations of the small atoms (N, B, Si, Al, P, and so forth) that lie near carbon in the periodic table of elements. Another group is made up of atoms that are larger in size but have higher valence to compensate—the transition metals that form carbides, nitrides, borides, and so forth.

The question of whether a crystal is likely to fail in shear because of dislocation motions can be answered quite simply by means of hardness measurements. If the hardnesses of various crystals are plotted versus their elastic moduli, the data fall into groups, Fig. 3.[4] For metals and ionic crystals in which dislocations move readily, the hardness value is a small fraction of the shear modulus (5×10^{-3} times the modulus for face-centered-cubic metals). In contrast, the hardness values for covalent crystals are relatively large fractions of their shear moduli (about 10 per cent of the modulus). Since hardness is a measure of the stress required to cause plastic flow, this shows that dislocations have great difficulty in moving through the latter crystals. Therefore it should be possible to realize high strengths with such crystals, even when they are imperfect in the sense that they contain dislocations.

The data of Table 4 indicate that, without being unduly optimistic, it should be possible to make materials with strengths up to 5,000,000 psi. This is 10 times better than present steels, and from the point of view of strength-to-weight is more than 20 times better. Furthermore, it is important to note that strong crystals can be formed from very inexpensive raw materials. In the beginning, fabrication costs will be high, but there is no apparent reason why the cost of these materials cannot eventually be quite low.

Design Difficulties

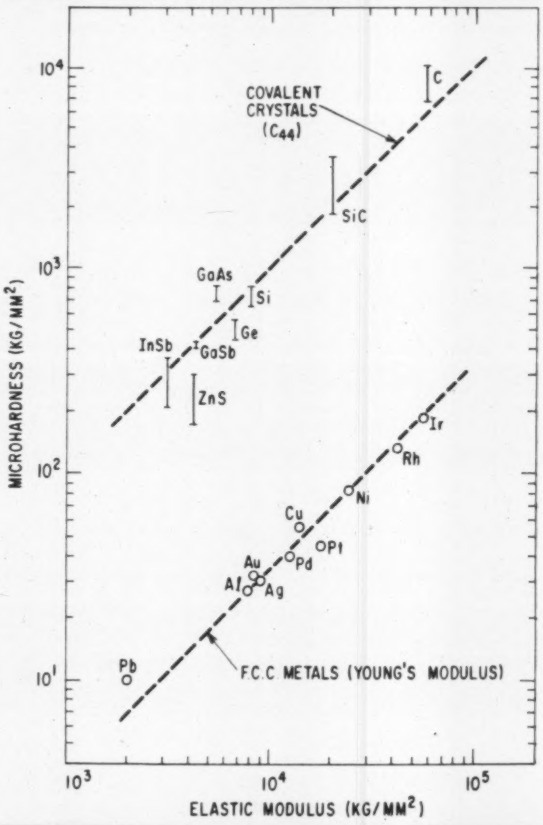
It will be difficult to design machines that use ultrastrong materials for structural parts. These materials will not have ductility because ultrahigh strength and ductility are incompatible properties. The crystals that have been discussed are frankly and unequivocally brittle. The writer has seen a bar of silicon all but disappear in a cloud of dust when it fractured at a stress level of 750,000 psi. It is understandable that the catastrophic way in which brittle materials fracture should be disquieting to the emotions of an engineer. However, it is possible to learn how to design structures that will perform reliably in spite of brittleness.

Lack of plastic flow in a brittle material makes it vulnerable to undamped impact loads, and especially to surface scratches. Since elastic waves are not appreciably damped when plastic flow is absent, the danger is always present that a wave will become so intensified during a series of reflections that it will cause fracture. Sharp impulsive loads will have to be avoided, and provisions included for damping reflections at free surfaces.

Surface scratches and other damage that is initially present on a surface can be removed by some form of chemical polishing (mechanical polishing is not suitable because it invariably leaves a damaged surface layer). Once a scratch-free surface has been prepared, it should be possible to protect it against subsequent damage. Fortunately, the stronger the material the fewer the things that can scratch it.

A surface coating of relatively soft, ductile metal would give the best protection because it would spread out the stresses produced by an abrading particle. A hard surface layer might prevent scratching, but it would allow local compressive stresses to be transmitted almost unabated to the load-bearing material. In combination with tensile stresses due to the main load, such compressive stresses would tend to produce high local shear stresses that might result in failure.

Fig. 3 It can be determined quite simply from hardness measurements whether or not a crystal is likely to fail in shear because of dislocation motions. If the hardnesses of various crystals are plotted versus their elastic moduli, the data fall into groups.



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[4] J. J. Gilman, "The Plastic Resistance of Crystals," *Australian Journal of Physics*, vol. 13, 1960. p. 327.

Table 4 Possible Strengths of Various Crystals

Crystal	Young's modulus, million psi	Density (specific gravity)	Maximum strength (5% strain) million psi	Strength to density ratio (arbitrary units)
Graphite	144	2.2	7.2	65
Diamond	115	3.5	5.8	33
WC	104	15.8	5.2	7
TiB_2	94	4.5	4.7	21
Al_2O_3	76	4.0	3.8	19
TiC	72	4.9	3.6	15
SiC	71	3.2	3.5	22
B_4C	66	2.5	3.3	26
ZrB_2	64	5.6	3.2	11
W_2C	62	17.3	3.1	4
W	60	19.3	3.0	3
$MoSi_2$	55	6.0	2.8	9
Mo	54	10.2	2.7	5
B	51	2.3	2.6	22
BeO	51	3.0	2.6	17
FeS_2	50	5.0	2.5	10
ZrC	50	6.8	2.5	7
NbC	50	7.8	2.5	6
Be_2C	46	2.4	2.3	19
Be	45	1.8	2.2	25
MgO	35	3.5	1.8	10
Si	23	2.3	1.7	10
Steel	28	7.8	1.7	4

Applications for Ultrastrong Materials

Cost and reliability requirements limit the potential application of stronger materials. One can hardly expect to use brittle materials for highly stressed aircraft parts until reliable performance can be assured. However, very strong, but brittle, materials are feasible for use in less vital machinery, and in many cases these would improve performance considerably.

A high-pressure press is an example of a machine whose performance is limited by materials strength.

At present, materials such as sintered tungsten carbide which are many times stronger in compression than tension are used for this purpose. Therefore, presses are designed to make the ratio of compressive stresses to tensile stresses as large as possible, and this severely limits the size of the high-pressure chamber that can be used. If material with the same or greater strength in tension were available, the chamber size would be unlimited. This could greatly improve present methods of high-pressure chemical synthesis. Also it would become possible to measure new properties of materials at superpressures.

Another machine that is limited by strength is the ultracentrifuge. One of the best ultracentrifuges produces a 1,000,000-*g* force in a few cubic centimeters of material. If a material with a strength of 5×10^6 psi were available, this could be increased to 100,000,000-*g*, and thereby open a whole new realm to experimentation on the effects of high gravitational fields.

Energy could be stored quite efficiently by means of flywheels or springs made of high-strength materials. Table 5 compares the volume energy densities that can be stored in various non-nuclear ways. A high-strength flywheel has a higher volume efficiency than almost any other method. Also the energy of a flywheel is readily available because it can be made part of an electrical generator, or perhaps operated directly as a homopolar generator.

Various kinds of cutting tools and drawing or extrusion dies represent another large group of devices that could be strikingly improved by high-strength materials.

The devices already mentioned could take advantage of ultrahigh strength for its own sake. Onthe other hand, almost any part of an aircraft or rocket could take advantage of the large increases in strength-to-weight ratios that can be achieved according to Table 5.

Feasibility and Timetable

Since elementary structural members have already been made from strong brittle materials, there is no reason to doubt their general feasibility. The only real questions regarding their practicality concern the complexity of the structures for which they might be used, and the cost of producing them in large quantities.

A silicon monocrystalline ring, Fig. 1, is a simple structural element that was formed by slicing a slab out of a $^3/_4$-in-diam crystal and "cookie cutting" a ring from the slab with an ultrasonic abrasive-cutting machine. The ring was then chemically polished to remove all scratches with a solution consisting of 3 parts concentrated HF, 1 part concentrated HNO_3, and 1 part glacial acetic acid. It was loaded at two points on the top side in Fig. 1 and at one point on the bottom side. The crystal was a commercial one purchased from the Merck Company that contained numerous dislocations. In the photographs, the <111> direction of the crystal lies horizontal.

Two crystal rings were tested. One broke at a load of 138 lb, and the other at 150-lb load. The maximum stresses were calculated in two independent ways. In one, the maximum curvature of the bottom leg of the ring in Fig. 1(*b*) was estimated, and the maximum tensile strain was calculated from this. This strain, times the elastic modulus, yields a maximum tensile stress of ~600,000 psi. The other method was to calculate the maximum stress at the inside surfaces of the curved portions of the ring using elasticity theory.[5] This method gave a value of 360,000 psi. Perhaps the most probable maximum stress is about 500,000 psi. Since the ratio of the density of steel to the density of silicon is 7.8/24 = 3.25, this is equivalent to a strength in steel of 1,600,000 psi in applications where weight is important. Previous tests by Dash[6] for a different geometry have yielded similar results.

Experiments symbolized by Fig. 1 have shown that it is feasible *now* to build simple engineering structures from brittle, but strong, monocrystals. As still stronger crystals become available, they will be increasingly attractive as engineering materials. Within 10 years, extremely strong tensile structures will have been built from diamonds or even stronger crystals.

Table 5 Comparison of Modes of Energy Source

Mode	Density of energy storage, million ft-lb/ft
Gasoline fuel	682
Solid propellant	105
Gasoline engine	99
Ag-Zn cell	15
Pb-acid cell	5
Compressed gas	2.5
Capacitor	0.2
Steel flywheel, 0.5 million psi[a]	45
Silicon flywheel, 0.75 million psi	68
Quartz flywheel, 1.0 million psi	90
Silicon carbide flywheel, 4.0 million psi	360
Diamond flywheel, 7.0 million psi	650

First group of data from: Kline, Marco, and Starkey, *Trans. ASME*, vol. 80, 1958, p. 909.

[a] Fracture strength in millions of psi.

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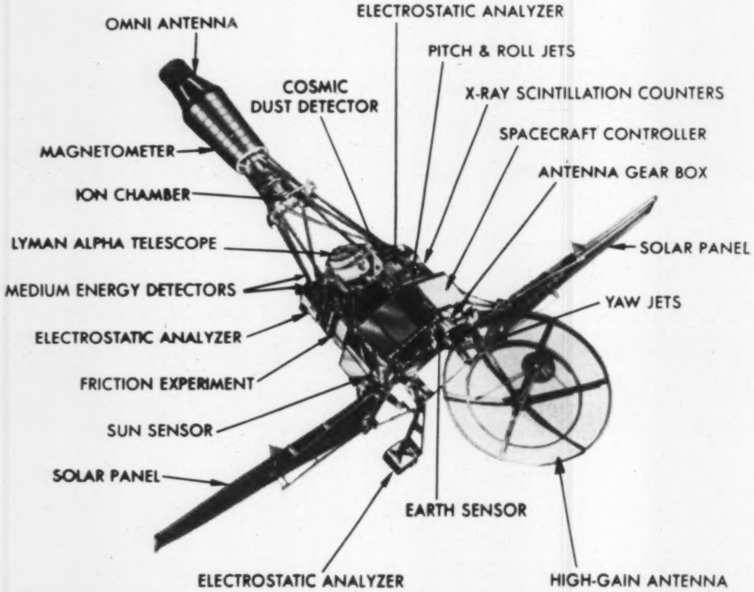
[5] S. Timoshenko, "Strength of Materials, Part II," D. Van Nostrand Company, New York, N. Y., 1930, p. 442.

[6] W. C. Dash, "Growth and Perfection of Crystals," J. Wiley & Sons, New York, N. Y., 1958.

Abstracts and
Comments Based
on Current
Periodicals and
Events

BRIEFING THE RECORD



The Ranger series is designed to land our first instrument package on the moon. Ranger I and II will first orbit in space to test the many complex components. Later shots will land on the moon.

Ranger Moon Probe

We will have a spacecraft on the moon early next year if the latest rocket series goes as scheduled. These shots, known as the Ranger series, will first orbit two test spacecraft to be sure all instruments are functioning properly. Then, Ranger III will orbit the moon and send back television pictures before crash-landing on the moon's surface. Later shots will soft-land on the moon and send back data.

The orbit followed is similar to that used by the Russians in their successful moon probe. The first stage Atlas takes the spacecraft to an altitude of about 115 mi, then the second stage Agena B boosts it into a "parking orbit" around the earth. From this orbit, the second stage, acting as a mobile space platform, blasts the craft into an orbit that will take it into space or to the moon.

The first shot. Ranger I, the first of these shots, is only a preliminary test flight. Since the instrument package is so complex (19,520 electronic parts), it is first necessary to test the design and operation of the package. The only way to do this accurately is in an actual space flight. With the reliability of the design established, more complex flights to the moon or the planets can proceed. Primary purpose of the flight is to check such construction features as an attitude stabilization system based on celestial references (the earth and sun), a high-gain antenna, an advanced communication system, and calibration of solar cells in a space environment.

As a secondary mission, Ranger I carries equipment for eight scientific experiments. They will study the nature and activity of cosmic rays, magnetic fields, radiation, and dust particles in space.

The design of Ranger I will probably set the pattern for spacecraft for some time to come. Though the instrumentation may vary, the basic structure will stay the same. Characteristic of this new design is the hexagonal base which carries many of the instruments. The designers are following a policy of standardization so that components of proved reliability are used as much as possible.

The orbit of Ranger I will not take it to the moon. Instead, it will have an elliptical orbit which will take it 685,000 mi from earth at its farthest point. On its return swing, about 58 days later, it will burn up in the earth's atmosphere. There is a possibility it may bypass the earth and become a satellite of the sun.

Ranger's construction. Ranger I, which was developed for the NASA by the Jet Propulsion Lab of the California Institute of Technology, is 5 ft in diam at its hexagonal base and 11 ft long. It has a span of 17 ft and a length of 13 ft when its various sections are extended in cruise position. Total weight is 675 lb with 243 lb for electronic equipment, 144 lb for the experiments, 50 lb for solar panels, and 238 lb for the structure.

Power for the craft comes from two winglike panels containing over 4000 solar cells. During the launch and part of the flight, these panels are folded against the sides of the craft. In space, they automatically extend to expose the cells to the sun's light. They are expected to be able to produce between 155 and 210 watts. However, it is uncertain just how much power they will produce. To resolve this problem before more complex spacecraft can rely on solar cells, there are four special cells in the panels that will monitor the performance of the solar cells.

Flight sequence. At a cut-off point 280 sec after launch, the Agena B second stage separates from the Atlas first stage. Spring-loaded bolts jettison the shroud that protected the Ranger during launch at the same time. At this point, the Agena B rotates until it is almost level with the local horizon, then it fires for the first time, accelerating to a speed of 18,000 mph. After $2^1/_2$ min of thrust, the Agena B shuts down and coasts into a parking orbit. For 13 min it coasts in this orbit around the earth until it reaches the optimum point in time and space to blast out into the second orbit. (Up to this point all operations have been telemetered to ground tracking stations through the Agena B system.) The craft is now headed for outer space at a speed of 23,800 mph. After two minutes on this new course, Agena B separates from the Ranger, makes a 180-deg turn, and fires its retro rockets. There are two reasons for this maneuver: first, to prevent the Agena B from reflecting sunlight near the Ranger and confusing the Ranger's sensors; second, to keep the unsterilized Agena B from landing on the moon in subsequent flights. The Agena B eventually burns up in the earth's atmosphere; the Ranger continues in its orbit.

Ranger controls. The next step is to start up the complex equipment aboard the Ranger. A master control, or brain, does this by issuing a series of ten commands that get the whole craft into operation.

This is the operating sequence:

At 25 min after launch—Step up power so ground stations can track more easily.

35 min—Turn on all scientific instruments not turned on at launch. (Since some equipment would not survive the shock of launch if in operation, they remain silent till now.)

36 min, 40 sec—Extend solar panels and electrostatic analyzer from sides of Ranger.

61 min, 40 sec—Turn on attitude control. This combination of gas jets, gyroscope, and sensors keeps the long axis of the craft pointed toward the sun. The sensors find the sun and the gas jets keep the craft positioned within an error of one degree. Once lock-on is made, the battery cuts out, and power begins to come from the solar panels.

90 min—Earth sensors come on and begin to hunt for the earth. When they pick it up, the gas jets change the Ranger's attitude so it is oriented in two planes. It must keep the solar cells toward the sun but the earth sensors toward the earth.

118 min, 20 sec—Change factor of telemetry measurement.

200 min—Make radiation detection instrument more sensitive.

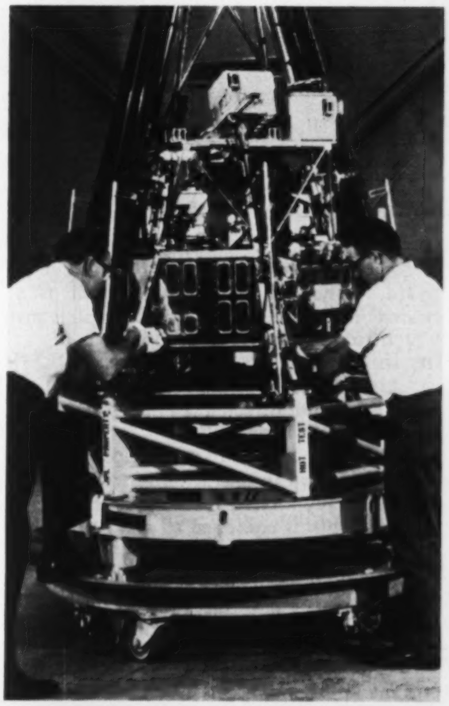
250 min—Send data from directional antenna, instead of omnidirectional antenna, to increasing broadcast range. The parabolic directional antenna was housed in the base of the Ranger during the early part of the flight.

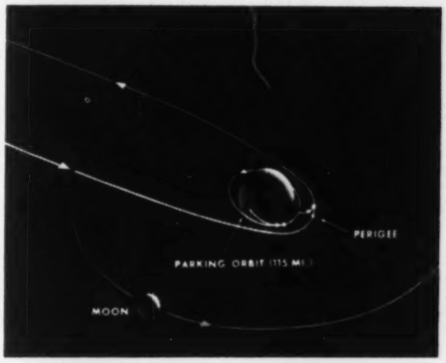
366 min, 40 sec—Reduce rate of transmission over omnidirectional antenna. Its low power is now near the limits of its broadcast distance.

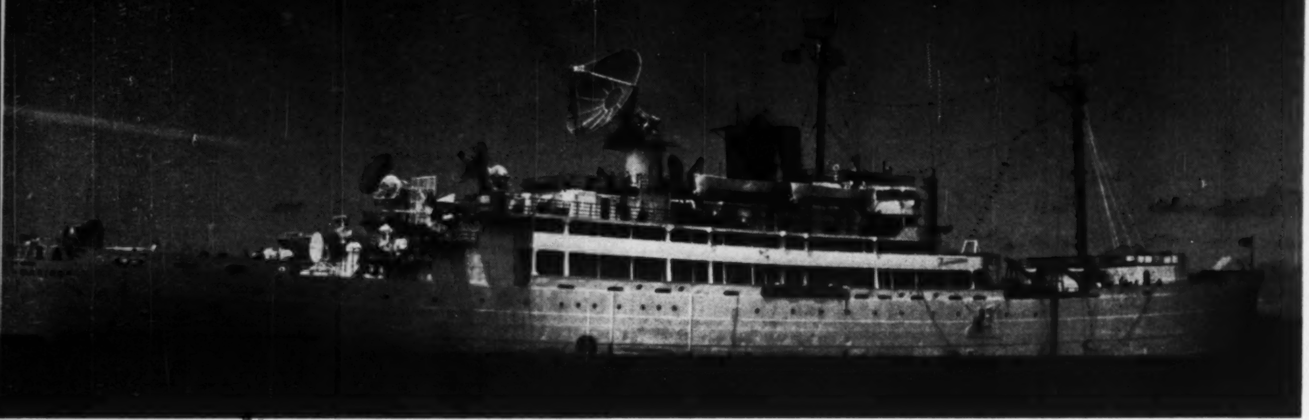
370 min—Turn on experiment that will determine some of the forces involving the operation of machinery in the vacuum of space.

With this last command the Ranger is completely operational and will continue to send data to its three tracking stations as long as its equipment is operational.

Ranger I in launch position has all its complex gear, such as the solar panels and directional antenna, tucked inside the main body, **top photo.** The high gain antenna that sends information back to earth is shown in the **bottom photo** in its extended position. Ranger I will have two orbits. First, a parking orbit around the earth, then into an orbit that will take it out into space and back again, as shown on **diagram.**







An old World War II Victory ship is now seeing service again as a missile tracker. The American Mariner observes the characteristics of missiles in the upper atmosphere with a complex arrangement of tracking instruments.

Downrange Missile Tracking

THE MISSILE tracking ship, the *American Mariner*, has undergone a two-million-dollar refitting at a Brooklyn shipyard. When it resumed its station as a seaborne laboratory it had one of the most complete instrumentation facilities on any vessel afloat.

The ship operates as part of project DAMP (Downrange Antimissile Measurement Program). This is a research program directed by the Army Rocket and Guided Missile Agency.

Since February, 1959, this remodeled World War II Victory ship has been in operation observing missiles from Cape Canaveral which fall into the South Atlantic impact area. This ship is equipped to make observations with radar, infrared tracker, and optical instruments. By using their complex array of tracking devices, the observation crew sights in on missile parts as they fall from the upper atmosphere and record physical characteristics of the re-entry. As they fall, the missile fragments emit particle trails. These trails and other phenomena are important in missile research.

As part of the improvement to the *American Mariner* the Todd Shipyard Corporation increased the stability of the vessel by relocating equipment and pouring concrete ballast. This reduces the ship's motion considerably, thereby increasing tracking accuracy.

RCA's Defense Electronic Production Division will also make a series of electronic installations and modifications. One of the major changes is the installation of two 16-ft-diam radar reflectors. RCA manages the ship's operation in addition to the radar.

The Barnes Engineering Company has the job of taking care of all optical tracking equipment. The optical measurements for which Barnes is responsible covers the spectral region from the far infrared through the ultraviolet, within the spectral limits imposed by the atmosphere. To implement this assignment, they have installed a number of optical measuring instruments, support equipment for these instruments, and data recording and processing equipment.

These include:

Dual ballistic cameras to provide a wide field of view and spectral record of the re-entry phenomena as a function of both range time and spatial orientation.

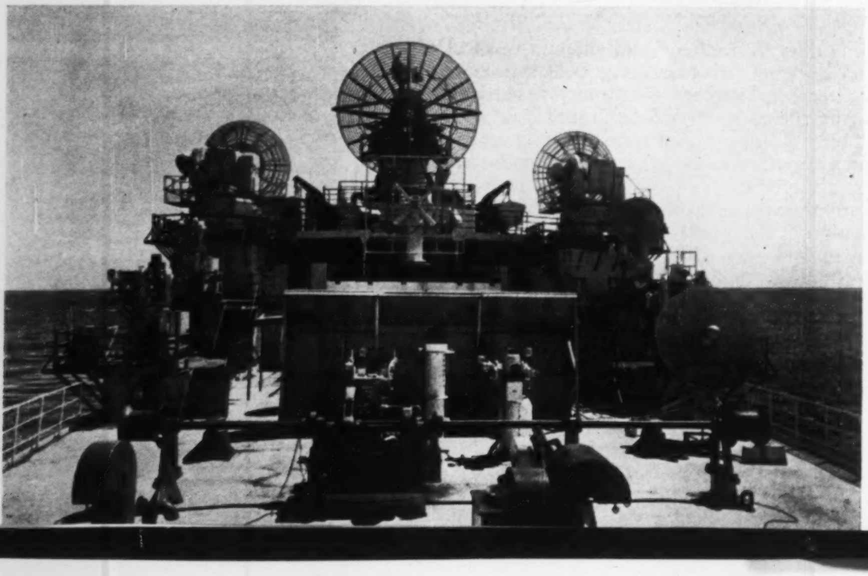
Spectral sequence cameras to permit an instant-by-instant record of the spectra of the re-entering bodies throughout visible and near infrared. They use transmission gratings and 70-mm sequence cameras.

A four-channel photometer provides absolute calibration values of radiation at several points in the spectral. Each channel uses a photomultiplier tube with a filter passing the narrow regions of the spectrum that are of special interest.

Other equipment includes a number of radiometer and a high-resolution cinecamera.

The air-conditioned ship is fully equipped with metal and wood-working shops and repair facilities for the electronic equipment. Since each missile is given detailed photographic coverage there is also a complete photographic laboratory. It has facilities to print and process still as well as 16, 35, and 70-mm film.

This view from the stern of the American Mariner shows the elaborate battery of radar reflectors, cameras, and infrared trackers used in missile tracking. Reading clockwise around the picture, the instruments are: Spectral sequence cameras and a four-channel photometer on two pedestals, **at left,** three radar antennas, radiometer, high-resolution cameras, and radiosonde on pedestals **at right.** Center pedestals contain infrared trackers.



Puerto Rican Opportunity

Puerto Rico has received its first U. S. military contract for production of electronics equipment. The U. S. Army Signal Corps has awarded a $479,000 contract for 57,000 military telephone handsets to Electrospace Corporation. This order will be manufactured at the company's new Puerto Rican plant.

A major impetus behind the contract to Electrospace was President Kennedy's recent policy of offering preference to labor surplus areas. Electrospace and more than 50 other companies have taken advantage of the preferential treatment offered to new business under the "Operation Bootstrap" program. Puerto Rico offers unique profit opportunities to all segments of the electronic industry. It is said that any electronic product that is lightweight or small with a high unit value or high labor content can be successfully and profitably manufactured in Puerto Rico.

There are several tax exemptions. Federal income taxes are not levied in Puerto Rico. In addition, qualifying manufacturers are exempt from Commonwealth and municipal taxes for 10 years. These include; Exemption from corporate income taxes for 10 years from date of commencement of operation; exemption from municipal license feeds for 10 years; and exemption from real and property taxes from 5 to 10 years, depending on the investment.

As an added service, the Puerto Rican Employment Service will screen and test applicants for work in the electronics industry to insure optimum skill for particular production operation. There is also a large pool of office workers and administrative executives who speak both English and Spanish.

Puerto Rico offers the benefits of a Foreign Trade Zone. ("A Foreign Trade Zone is an enclosed and policed area where foreign and domestic merchandise may be brought in without being subject to customs laws governing the entry of goods or payment of duty thereon.") The Puerto Rican Zone is much like others operated under the U. S. flag, with special advantages. However, this is the first zone to stress manufacturing operations. In addition, there are some extra advantages.

A manufacturing company inside the Puerto Rican Zone is eligible for a $20,000 cash incentive to cover one year's free rent, half the cost of shipping machinery and equipment, and the salaries of instructors brought in to train workers.

The industrial buildings in the zone are available at rentals of 50¢ and up per sq ft a year.

U. S. manufacturers can bring semifinished goods or components into the zone, have them fabricated at low cost into a finished product, then shipped out again duty-free, or at special rates.

There are no quota restrictions on raw material and components brought into the zone.

New Features of Tiros III

The Tiros III weather satellite, now in orbit, is part of one of our most successful space programs. The three Tiros satellites launched to date have extended the horizons of meteorological science by providing thousands of useful pictures of the earth's cloud cover.

These satellites, built for the NASA's Goddard Space Flight Center by RCA, have an impressive record.

- Tiros I, launched April 1, 1960, produced nearly 23,000 pictures of the earth's surface.
- Tiros II, launched November 23, 1960, is still transmitting televised cloud pictures to earth after several months in orbit. It has provided an even greater number of photographs than Tiros I, as well as infrared data.
- Tiros III, launched July 12, 1961, is scheduled to operate about three months in space.

Although Tiros III is identical in size and shape to the other Tiros satellites, there have been a few new features added. Instead of the single wide-angle camera carried on the first two, Tiros III has two cameras. Each camera will photograph cloud patterns over an area of about 700 miles on opposite sides of the satellite.

New infrared equipment on Tiros III consists of an omnidirectional sensor system carried on outriggers on opposite sides of the satellite's base. The sensors determine the thermal radiation characteristics of the earth by measuring the heat radiated toward earth by the sun, and the amount that is reradiated from the earth's surface and atmosphere.

Also new are the electronic "clocks" which trigger the operation of the television cameras and other equipment at any desired point in orbit. These clocks function in accordance with the program sent to the satellite as it passes within range of a ground station. The new circuits, which replace an arrangement of moving parts in the earlier Tiros clocks, are expected to add to the satellite's reliability.

Tiros III is also carrying many instruments that were proved reliable in the first two satellites. There are RCA $^{1}/_{2}$-in. Vidicon television cameras, each associated with a magnetic tape recorder which can store up to 32 pictures for transmission to earth on command. The new Tiros also has a magnetic orientation system that was first used on Tiros II. It enables ground observers to shift the satellite's tilt in space without special propulsion devices.

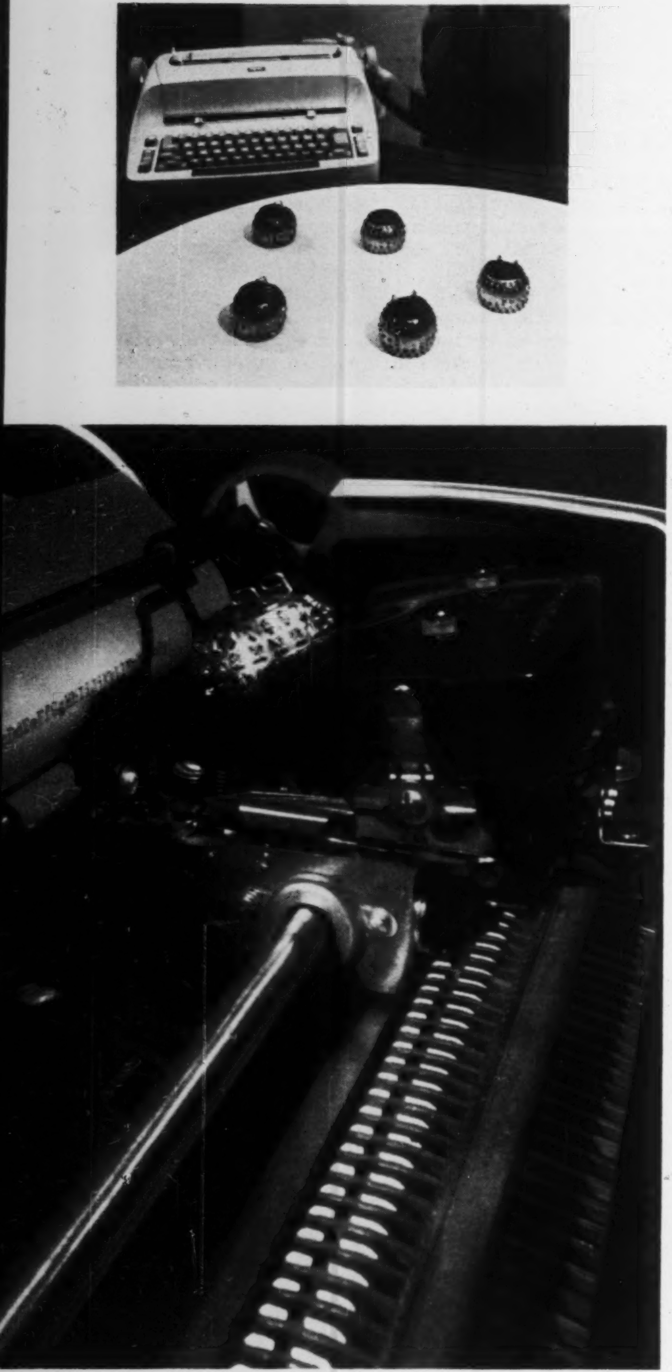
Computer Census

More general-purpose computers are now on order than have been produced and installed during the past 15 years. Manufacturers are expected to deliver over 7000 general-purpose computers during the next 24 months.

Installation rate of solid-state computers rose 141 per cent since January, 1961. These figures from the 7th semiannual John Diebold and Associates, Inc., computer census indicate 5371 computers had been delivered by June 30, 1961. Of this total, 3776 were "vacuum-tube" machines and 1595 were the newer transistorized (solid-state) systems. There are 91 fewer vacuum-tube computer systems in operation than were "on line" in January, 1961. This is a decrease of 2.4 per cent in the past six months.

Percentage increases in the major solid-state computer groups are: desk-type up 115 per cent; medium systems (renting from $12,000 to $25,000 per month) up 111 per cent; and large systems up 112 per cent.

New computers delivered for the first time include the Bendix G-20, the RCA 301, the Sylvania 9400, and IBM's STRETCH. Recently announced general-purpose systems which appear in the census for the first time are the B5000 and the 251 Visible Record Computer from Burroughs, the 310 from National Cash Register Company, and the IBM 7072.



The new IBM carriageless typewriter has all the type on a single sphere instead of the conventional individual type bars. Press a key, the sphere positions the character, and types it. The entire printing mechanism moves across the paper on its carrier, typing as it goes. There are several different type faces to choose from. The typewriter is presently available in two sizes, to take 11 or $15^1/_2$ in. paper. Prices are $395 and $445, respectively. Price of present standard carriage model is $440.

IBM Carriageless Typewriter

IBM has a new electric typewriter without type bars or a movable carriage. The typewriter uses a single spherical element containing all the characters instead of individual type bars. The keyboard has the conventional arrangement.

When typing, the sphere-shaped element moves from left to right on its carrier across the paper, selecting and typing the desired characters and symbols as it moves. Since the type itself moves across the paper there is no need for a movable carriage. The stationary carriage reduces desk space requirements for the machine, and eliminates vibration and carriage return "jolt."

The sphere contains one complete set of characters. When a key is pressed, the sphere positions that character and types it. Since the characters are located all over the sphere, the indexing mechanism must rotate and tip the sphere to position the characters. The machine finds and strikes characters faster than the eye can follow.

Since practically all the action takes place in the center of the carriage, there is none of the complex linkage found in the standard typewriter.

The IBM "Selectric," as the new typewriter is called, has a selective stroke storage system incorporated into it which increases a typist's speed and accuracy. If two characters are struck nearly simultaneously, only the first is typed, while the system automatically stores the other for a split second, and then types it immediately. This system and other mechanical capabilities of the Selectric are said to give the typist more useful typing speed than is available on conventional machines.

Another feature of the new typewriter is the variety of type styles it offers. The sphere-shaped element may be removed and replaced with another type style in seconds. Customers will choose the type style best suited to their need from six type faces.

Instead of a ribbon spool on each side of the machine, as in conventional typewriters, a ribbon cartridge containing two spools side by side is mounted on the carriage.

SR-1 Accident Report

The Atomic Energy Commission has released a report on the explosion of the SR-1 reactor. In this accident, which occurred last January 3, three men were killed, the first fatalities in the history of U.S. nuclear operation.

The board of investigation could not assign the cause for the explosion to any specific act or condition preceding the incident. However, they did find that, before the accident, the condition of the reactor core and the reactor control system had deteriorated to a great extent. In the light of this situation, reactor operation should not have continued without corrective action.

The change in reactivity which caused the explosion appears to have occurred "as the result of some abrupt structural failure in the reactor or by an unusual movement of the central control rod." One theory is that the control rod became stuck.

The report states: "There appears to have been some lack of clear definition of assignments within the AEC of responsibility of ensuring continuing reactor safety appraisals and inspections. . ."

As a contributing factor to the accident it was noted that "the training and ability of the operating organization appears not to have been entirely adequate, since substandard conditions were allowed to develop in the reactor and its components and yet, reactor operation was allowed to continue."

As to fixing responsibility, the Commission could not limit it to one person or group of persons. But the operating contractor, Combustion Engineering, Inc., had immediate responsibility for all reactor operation. The AEC's Idaho Operations Office, the Division of Reactor Development, the Division of Inspection, and on up to the General Manager, all share in the blame.

Graphite and Metal Combined

In a new patented process, developed by Ford Motor Company, graphite can be combined or wetted with metal. Dixon Sintaloy is the exclusive licensee under the Ford patents to produce the new materials for commercial sale in the U. S.

Iron, nickel, copper, silver, cobalt, and alloys of these materials can be combined in proportions varying from 90 to 10 per cent of graphite. Applications of these materials are foreseen in self-lubricating bearings, graphite metal brushes, electrical contacts, seals, resistance elements, and nuclear applications.

The new process provides intimate bonding between graphite and metal giving improved mechanical and electrical properties. The usual brittle characteristic of graphite is greatly reduced in some compositions and eliminated in others.

The initial evaluation indicates a transverse rupture strength up to 50,000 psi and compressive strength up to 120,000 psi. The material has a pressure value up to 200,000 as compared with standard self-lubricating bronze of about 25,000. Some compositions of graphite and steel can be heat-treated by conventional means. Little if any machining will be required on final components according to present indications. The material is malleable enough to be sized in production equipment at high speed, even to exceptionally close tolerances.

What's That Again?

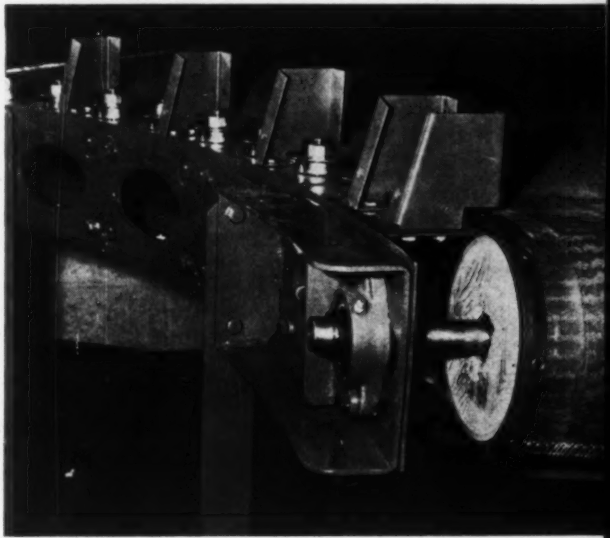
Each year, industry pays millions for mistakes directly traceable to faulty hearing on the part of some key employee. Merchandise is shipped in wrong quantities to incorrect destinations, phone orders are garbled, and company good-will dissipated because "somebody" failed to get his information straight. Chances are that "somebody" is one of the 15 million people in this country—one in 12—reported to be suffering from a hearing deficiency.

In order to detect such people before they are hired, Universal Electronics Laboratories, Hackensack, N. J., suggests you try their new audio testing device called the "audiometer." In an eight-minute test this device can determine whether or not a subject has normal hearing ability. It is a little larger than a portable radio with a frequency range of 125 to 800 cps and a decibel range of 10 to 100 db. If these hearing tests catch on, they may become as common to the pre-employment physical as an eyesight acuity test.

The audiometer is simple enough to be operated by a company nurse or personnel officer. It should prove of greatest value in industries and occupations where employees are subjected to above-average noise ambients. The normal speech ambient is about 60 db. Compare that figure with the 100 to 120 db in a steel or textile mill, or the 135 db to which ground crews of jet aircraft are subjected.

The daily assault on the hearing faculties of people working under these conditions may result in hearing deficiency over a period of time unless some sort of protective device is used. In any case, these people should be given hearing tests at least once every six months to detect incipient hearing loss.

Another consideration of industry in estimating the worth of this hearing tester are the compensation laws in force in several states and pending in others. These laws recognize hearing losses incurred through employment as legitimate grounds for disability claims.



Steel rods spread stresses and special idlers bear against the belt's edge to make possible a conveyer system that can bend around 180 deg.

Curving Conveyer Belt

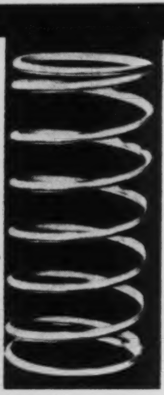
Goodyear is working on a new conveyer belt that carries material around corners. This new system transfers material from one belt to another without the disadvantages in systems using only straight-line conveyers.

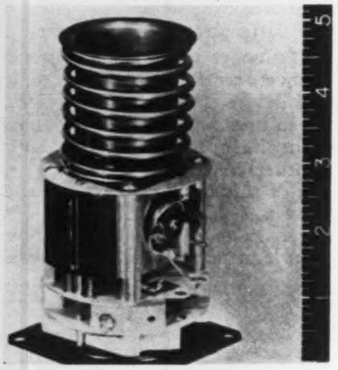
Usually conveyer systems will have some kind of barrier that diverts material from one belt to another. With this method there is the problem of the barrier scuffing and breaking packages, the possibility of material getting wedged against the barrier, and material unevenly distributed on the second belt.

In the new system, called "Curve-Flo," material flows continuously around corners; items are placed on the second belt in exactly the same position as on the first. Packages do not touch any obstructions.

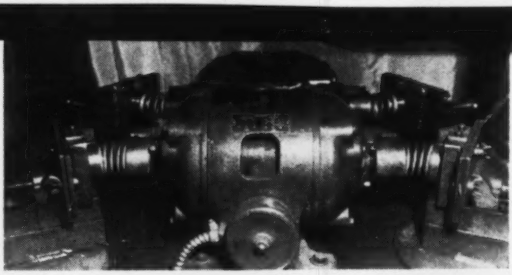
To achieve this unique bending ability, the belt is inlaid with steel rods that keep it flat on the conveyer bed, even at high speed. The rods spread stresses across the belt's face. As protection against wear, the rods are set in channels of polyurethane rubber. Restraining idlers along the belt's inside radius help avoid strain and wear on the belt material.

The Curve-Flo principle will probably be used most in mail, luggage, and packaged-goods handling. Several installations already are being built for new post offices.



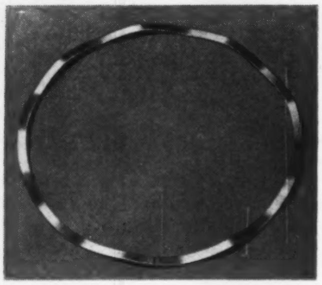


▶First level. Springs must be the ultimate in reliability. They can never fail. This spring must exert an unfailing 26-lb kick to separate a Vanguard satellite from its third-stage rocket.



▶Second level. Springs may fail rarely in extreme service, but never in normal service. Here, engine valve springs of this category are given fatigue tests.

▶Fourth level. Springs are those of least reliability. Price is the most important consideration, so occasional failures are expected. An example is this wavy-spring washer used as a seal ring in high-temperature applications.



Reliability in Spring Design

Springs are among the few devices which can be made to operate at 100 per cent reliability. Unlike many items in electronic circuitry, for example, springs do not function on the sacrifice-of-elements principle; hence, they have no burn-out limit to prevent infinite life.

If a spring must have absolute reliability, it can usually be made that way. Almost any condition of temperature, load, and time cycle can be compensated for by massive multiplication of safety factor in materials and stress levels, or by forced cooling.

Springs are basically mechanical energy storage-and-release devices intended to carry loads and sustain stresses. However, the engineer is seldom free to concentrate solely on such aspects of the design problem.

In an article by William R. Johnson, Associated Spring Corporation, Bristol, Conn., the author states that the spring must always be designed for one of four levels of operation:

1 Services so critical that failure must not occur under any circumstances.
2 Design considerations which may result in a rare failure in extreme service but almost never in normal service.
3 While price is paramount, failures must be insignificant in number.
4 Space or price so vital that random failures are expected.

Typical of the first level would be a space-vehicle spring. In this problem the designer would have unrestricted call upon the most exotic materials in metallurgy; could have access to the most modern production processes; and would not be impeded by the cost of 100 or 200 per cent inspection. Duplication of piece-by-piece examination with high rejection and laboratory certification of each individual spring's ultimate performance limit would not be a deterring factor. There must be sufficient space available so that restrictions on design can never be permitted to compromise reliability.

The second level of reliability—where failure is inevitable but must be extremely rare—is well exemplified by aircraft-engine valve springs. In this instance, the designer must consider carefully what failure would mean. If it would involve only partial loss of power, it is serious but not fatal. However, space, weight, and production requirements are such that an absolutely failure-free spring cannot be guaranteed at the present level of technology.

Automotive applications are prime examples of the third level of spring reliability. Price is paramount, but failures must be at a minimum.

Valve springs in particular must be designed to highest feasible stress ranges to comply with severe restrictions in space and cost imposed by competitive conditions. Economics demand that the safety factor never be excessive, yet reserve strength must be high enough to meet the small percentage of use when engines may be cruelly overworked. Springs must be designed to reduce surging while insuring tight seal under modern compression ratios without excessive valve-train inertia or cam wear—both within the framework of low material and production costs.

The fourth level of reliability—where space or price is vital—can be illustrated by two examples. Certain wavy spring washers are used for seal rings in high-temperature applications. Because of very limited space, the stresses on the washers are so high that, at the operating temperatures (over 1000 F), they set appreciably after several hundred hours of operation. Other parts of the mechanism are similarly affected. As a result, normal maintenance calls for replacement of these parts, including the washers, at regular periods.

Inexpensive spring-powered devices, such as some toys, are examples of the importance of price. Normal wear-and-tear and "obsolescence" of these toys are such that the economics favor risking an occasional broken spring.

What are the constructive steps both designer and springmaker can take to interpret the user's requirement? From the designer's standpoint they are two: avoid reliability specifications beyond the service requirements of the spring, and don't overdesign.

From the springmaker's viewpoint, the recurring dilemma of reliability is cost. Fortunately, new developments in the industry in configuration, processing, and the like significantly increase reliability without cost penalty. Knowledge of metal behavior further permits the use of conventional formulations without resorting to costly alloys or machining.

In the final analysis the most vital factor in attaining spring reliability is co-operation between designer and springmaker. Working together, their skills can continue to meet any requirement for spring reliability with precision and efficiency.

Time Signals Changed

The National Bureau of Standards has advanced the phase of the time-signals broadcast from stations WWV and WWVH by 50 millisec. The change went into effect at 0000 Universal Time, August 1, 1961. Departure of the time scale from Universal Time reflects a small, but perceptible, fluctuation in the earth's speed of rotation.

Similar changes were made simultaneously on the other standard frequency broadcasting stations which have been co-ordinating their transmission since early 1960. These changes were made under an agreement between the United Kingdom and the United States.

Co-ordination of these signals will provide a more uniform system of time and frequency transmissions throughout the world which is needed in the solution of many scientific and technical problems. These include such fields as radio communications and satellite tracking.

The transmitting stations included in the co-ordination are GBR and MSF at Rugby, England; NBA, Canal Zone; WWV, Beltsville, Md.; and WWVH, Hawaii.

Continuous Density Measurement

Fluid density can be measured continuously by a new device called a Densitor made by the Co-Engineering Company, Boonton, N. J. It consists principally of a spring-supported tube connected to a source of the material being measured. An arrangement of electromagnets, a sensing coil, and an electronic amplifier vibrates the tube at its natural frequency. Since resonant frequency is a function of the total mass and the spring rate of the suspension, it is proportional to the density of the material in the measuring tube. A frequency converter changes resonant frequency to a meter reading.

The device is then able to sample continuously the material and give a reading of its density. Fluid velocity, attitude, and gravity have no effect on the Densitor, according to the manufacturer. The instrument causes no physical or chemical change in the sample.

It weighs less than 15 lb, has an operating temperature range of −65 to 200 F, and a pressure range of 15 to 200 psi. Speed of response is about 10 millisec.

Heatless Plastic Bonding

Here is a device that is said to solve the problem of bonding the "miracle" plastics and fabrics. By using ultrasonics this machine can weld materials that defy bonding by conventional means.

It's called the Ultra Sonic Sealer and it's made by Kleer-Vu Industries, Inc. With it you can bond or weld most of the new fabrics and films without heat and without noise, leaving the material practically unmarked.

The list of materials that can now be permanently and instantly bonded include: Mylar polyester, polyethylene, polypropylene, nylon,and vinyl films, synthetic woven fabrics of nylon, and Orlon acrylic and Dacron polyester fibers. It can also fuse plastic or plastic-coated materials to paper or fiber. The device can cut, seal, and make butt, lap, seam, spot, or continuous welds.

Here is how it works. Two pieces of the material to be bonded are sandwiched between a solid anvil and a continuously hammering tool. The tool vibrates at a rate of 20,000 blows per sec. The force of these blows—up to 2000 psi— releases kinetic energy within the material, producing a natural molecular bond. There is little deformation, distortion, or change in the properties of the bonded material. Any heat that is generated dissipates into the cold mass of the anvil and the tool, leaving the out surfaces of the material cool. Because the plastic stays relatively cool, special molecularly oriented films do not fully lose their characteristics at the weld area. With the new sealer, even heat-shrinkable films used in tight packaging of foodstuffs are not distorted or shrunk at the weld area.

The Ultra Sonic Sealer consists of two separate units. First, the drive unit, which generates an oscillating electric current; and second, the welding unit, which converts the electric power into mechanical strokes. The welding section, or head, has a transducer and the cone-shaped operating tool. The head is mounted on an adjustable base which may be used as an anvil. Both the head and drive unit can be put alongside each other so that the controls of the drive unit are accessible to the welding operator.

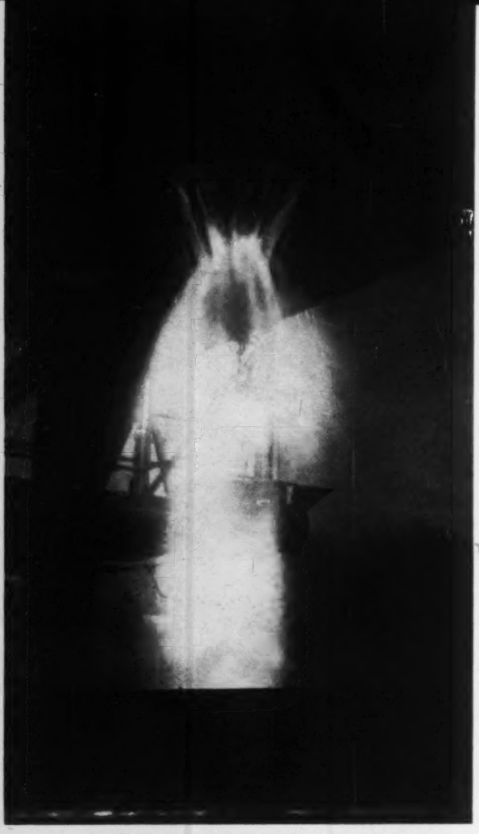
The sealer can be used with materials ranging in thickness from one quarter mil to 100 mils. In continuous welding, sealing speeds of 100 linear feet per min have been obtained.

As an added feature, the Ultra Sonic Sealer cleans as it seals. It will seal through contaminates such as grease, powders, paint, printing ink, and oil. It is not necessary to scrape or clean the surfaces prior to bonding.

When the sealer is put into production line operation it can be set up to work in a vertical or horizontal position. It may also be used for separate station production.

The tool's safety is another important factor. An operator can touch the "hammering" tool while it is running without risk of shock or burns. Since there is no heat buildup, the manufacturer claims it can be used with complete safety in the presence of explosives or inflammable material.

The Ultra Sonic Sealer uses a head, vibrating at high speed to weld the ends of this Mylar strip together. It creates a permanent seal without damaging the plastic.



This new plug nozzle rocket engine has operated at thrust levels of 50,000 lb. Combustion occurs in several wall segments rather than in one large chamber.

Plug Nozzle Engine

A ROCKET engine with plug nozzle design is being investigated at the General Electric Rocket Test Station in Malta, N. Y. This rocket differs from conventional design in that it has a funnel-shaped combustion chamber which is only half as long as the usual bell-shaped combustion chamber.

This engine developed more than 50,000 lb of thrust during recent test firings. However, G. E. engineers claim the engine can be scaled up to multimillion-lb thrusts in less time and at less cost than with today's conventional rocket propulsion systems.

Combustion in the new engine occurs in small segmented combustion chambers located around the periphery of the conical plug. By increasing or decreasing the number of these cells, engines of various thrusts can be built without developing a new injector for each engine size.

Rockets carrying this type of engine can be steered by simply varying the pressures in the combustor segments. Conventional engines, on the other hand, require a gimbaling structure which mechanically turns the engine to change the direction of thrust.

The plug nozzle is being studied for use as a multimillion-lb booster for large payloads, as an upper-stage engine, and for space station propulsion.

Better Technical Illustrations

ALTHOUGH many technical articles are well written, the drawings and graphs are often of poor quality. Joseph Getsko tells how this can be prevented in an article in the May issue of *Graphic Science*.

Mr. Getsko, who is head of the drafting department of Westinghouse Research Laboratories in Pittsburgh, and an ASME member, suggests the work of producing graphs and drawings for technical articles be completely isolated from the normal drafting effort. Employees can be hired who have art rather than drafting ambitions. First, they have been trained in the use of the Leroy lettering instrument and in the drafting practices needed to make good quality art for reproduction. Then, they can begin to share the productive load of the drafting unit.

As a training aid, the person doing the art work should be given some simple rule as well as a standard to follow. This can eliminate both time-consuming calculations and slipshod guesswork.

A chart can supply most of the necessary information in an easily understood form. Moreover, when followed, it gives the finished work a uniformity that distinguishes both the draftsman and the publication where it ultimately appears.

This chart might include line widths and lettering sizes for captions, dimension lines, cross hatching, general printing, and so on.

It's important to know what minimum letter height the publisher wants after the art work has been reduced. Therefore, establish a basic size after reduction and use it as a basis for the chart. Usually, lettering sizes have to be chosen to fit the available Leroy guides, but any number of line widths can be chosen since they are easily controlled by adjusting the ruling pen.

Molecular Computer

A MOLECULARIZED computer, one tenth the size and weight of a transistorized computer but with the same capabilities, is now under development at the Westinghouse Electric Corporation's air arm division.

The new device, "Mol-E-Com" (for "molecular computer"), will have greater payload capabilities for American rockets through the use of the promising new approach to electronic systems—molecular electronics.

Molecular electronics makes the familiar tubes, transistors, and resistors unnecessary. In place of these components, a solid semiconductor crystal performs the same functions through the rearrangement of its internal structure to form a functional electronic block. Electronic behavior occurring within or between regions of the block gives the same effect as an electronic circuit. In the Mol-E-Com, such blocks will perform intricate electronic operations such as switching, amplification, or other logic functions.

Mol-E-Com will weigh less than 15 lb and occupy less than one third of a cubic foot instead of the 175 lb and 3 cu ft required by a similar conventional transistorized computer. More important than the 10-to-1 size and weight reduction, however, is the anticipated reliability of the molecular blocks that make up the "brain" of the computer.

Molecular electronic design of systems, including the computers, reduces the number of connections and components; therefore there are fewer points of possible failure. In one instance, 26 molecular blocks do the work of 118 conventional parts, and a study is well along to reduce the number of molecular blocks to six.

The easy serviceability of Mol-E-Com is an additional feature in making it a valuable piece of equipment. The molecular components will be easily reached and replaced as units when a malfunction is located.

Thermionic Diode

Direct conversion of heat to electricity is possible with a device called the thermionic diode. Essentially, it is two parallel metal plates, separated by a gap a fraction of an inch wide.

In operation, one of the plates—the emitter—is heated; electrons boil off it, pass through the gap, and collect on the cooler collector plate. When two plates are connected through an outside electrical circuit, a flow of electrons will pass through the circuit and perform useful work.

The thermionic diode is somewhat like a battery; if it is hooked up to a circuit, it will provide a current. In the May, 1961, issue of the Arthur D. Little, Inc., *Industrial Bulletin*, the thermionic diode is described as potentially better and simpler than the steam turbine. In further describing the device, the article states that energy must be supplied in the form of heat to boil electrons out of the emitter, just as it takes heat to evaporate water. For each metal, it takes a specific amount of energy to remove an electron from its surface; this energy is called the work function and is measured in electron-volts. Conversely, when an electron is condensed onto a metal surface (as on the collector) it will give up energy in the amount measured by the work function of the collector metal.

Unfortunately, the amount of power available from a thermionic diode is limited by what is called the "space charge." All the electrons boiled off the emitter are negatively charged, and the total charge in the space between the emitter and collector is enough so that the electrons repel one another. Thus some electrons are prevented from bridging the gap, and the diode is not as efficient as it might be. The best thermionic diodes made so far operate at 15 to 20 per cent conversion of heat energy to electrical energy.

Removing Space Charge. The space charge limitation might be removed through several approaches. One is simply to make the spacing between the emitter and collector so small (less than 0.001 in.) that no charge would build up—but this approach introduces manufacturing difficulties and operating problems. A second approach is to introduce a cloud of positively charged ions into the space which neutralizes the space charge. This has been done successfully using cesium vapor, which ionizes when it comes in contact with the hot emitter. A more novel approach now under consideration is to make the emitter itself out of some fissionable material, thus providing both a source of heat for the emitter and a source of radiation which produces positive ions that negate the space charge. The higher the temperature of the emitter the greater the flow of electrons and, assuming the space charge problem can be overcome, the higher the efficiency.

The instructions for the Autopromt machine-tool control are formulated from 180 English-like statements

The first steps toward engineering design are already being taken. For example, engineers are considering the use of thermionic devices as "topping units" operated in conjunction with nuclear reactors. Here the thermionic diode would make electricity from the high-temperature heat generated by fission, and the exhaust heat from the system could then be used to drive turbines to make more electricity. The over-all efficiency of such a system—the ratio of electrical energy produced to heat energy consumed—could approach 60 per cent. By contrast, efficiency of the best nuclear power plants today is only about 30 per cent and that of large coal-fired plants about 40 per cent.

A purely thermionic nuclear power plant, operating without expensive turbines, would have the double advantage of high efficiency and low capital costs. And this approach in turn might be the way to reach more rapidly the real objective of research in thermodynamics—lower-cost electric energy.

3-D Machine Tool Control

IBM's AUTOPROMT (Automatic Programming of Machine Tools) is said to be the first that enables the user to describe the surfaces of a 3-dimensional shape to be milled, rather than each path the tool must follow to machine the part. Autopromt leaves to a computer the task of automatically generating these tool paths on the basis of a simple description, in English-like terms, of the part to be milled and the tool to be used.

From a blueprint, statements in the Autopromt language are written to describe the part completely. A solid-state IBM 7090 computer—using this information and controlled by the Autopromt master program—generates all the tool-path instructions. They spell out to the tool every motion required to machine the part. A milling job can be completed in about one fourth the time required to machine the same part conventionally.

The English-like language used by Autopromt enables the part programmer to describe the surfaces to be milled in familiar shop terminology. There are 110 words in the Autopromt vocabulary. Using this language, the programmer describes each geometric surface, defines the relationships of these surfaces to each other, and specifies the machining requirements.

For example, the programmer might use the following statement to define a bowl-shaped surface of a part:

Bowl = Sphere, inside/center (0,0,0) radius (1.75)

The machine has diagnostic abilities which enable the computer to indicate by printed reports many types of errors which occur in the part description. For further verification a printed list of co-ordinates for each tool position is prepared by the computer. These positions can be read or plotted to enable the manufacturer to visualize the path of the tool before the part is produced.

Space Dust Trap

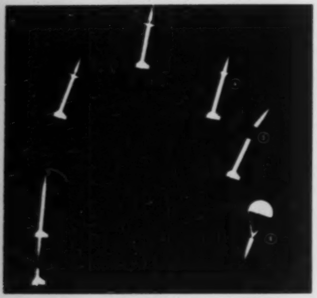
An attempt was made recently to trap and recover extraterrestrial dust from outside the earth's atmosphere for the first time. In this test, an Aerobee-Hi sounding rocket was fired more than 105 miles above the New Mexico desert. The flight resulted in the discovery of a dense band of dustlike micrometeorites surrounding the earth.

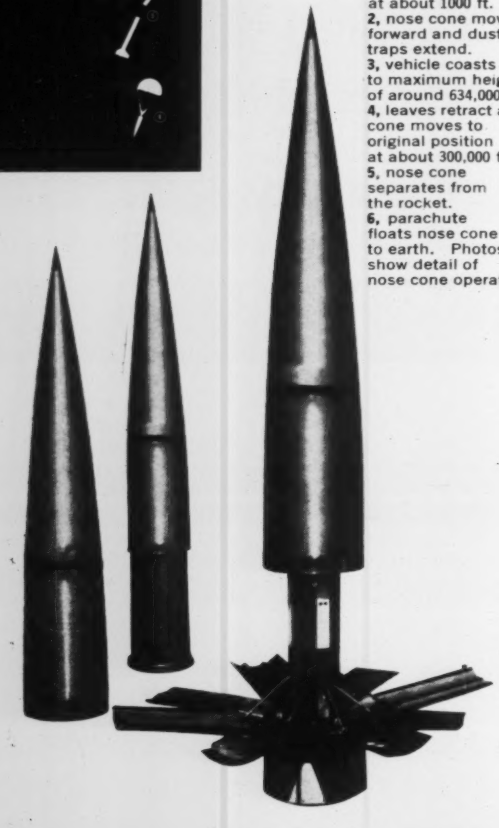
These dust particles or micrometeorites—measured in microns—pose a potential threat to space travelers. Despite their minute size, their high velocity (6.8 to 47.8 miles per sec) makes them as lethal as bullets.

To trap these particles, the nose section of the rocket operates similar to the Venus-fly-trap plant. When the Aerobee-Hi reaches an altitude of about 40 miles, the nose cone moves forward and exposes eight inner leaves which then extend.

Equipment to snare the space dust particles consists of boxes containing electromicroscope screens and plastic material, 3 in. by 2 in., in triple layers on each of the rocket's leaves. They remain extended as the rocket coasts upward to 105 miles and then drops back to 55 miles. At this point the leaves retract and the nose cone section returns to its original position. At a height of around 50 miles the nose cone separates from the rocket body and is finally brought to earth by parachute.

The Aerobee has the longest record of continuous production and use of any rocket vehicle. It's been going strong since 1947. A follow-up model, the Astrobee, is now coming into regular service.





The diagram shows the rocket's flight sequence. **1,** booster drops off at about 1000 ft. **2,** nose cone moves forward and dust traps extend. **3,** vehicle coasts to maximum height of around 634,000 ft. **4,** leaves retract and cone moves to original position at about 300,000 ft. **5,** nose cone separates from the rocket. **6,** parachute floats nose cone to earth. Photos show detail of nose cone operation.

Rhenium-Tungsten Alloy

Chase Brass and Copper Company is now producing rhenium-tungsten alloy. This development makes possible a new range of high temperature measurements and more reliable electronic components because no other metal has such elevated-temperature strength plus ductility at room temperature.

For example, a tungsten-25 rhenium (W-25 Re) and tungsten thermocouple has an operating temperature range of up to 5400 F, whereas the platinum group thermocouples are effective only up to about 3000 F. W-25 Re also has much better weldability than pure tungsten. And, since electrical resistivity of the alloy is somewhat higher than that of pure tungsten, it can be made into more rugged filaments and heaters.

Rhenium, although one of the rarest of the refractory metals, is potentially available in quantities of 20,000 to 30,000 lb per year. Alloys of rhenium as well as rhenium itself are produced by power metallurgy techniques.

Here are some of the uses of rhenium and its alloys:

Electronic—Filaments for mass spectrographs, ion gages, grids, and heaters in tubes.

Electrical—Coils in compact electromagnets, electrical contact material, heating elements for resistance heated furnaces.

Thermocouples—Temperature measurement and control to 2750 C.

Welding Filler Rods—Or as an interlay or overlay for obtaining ductile welds in molybdenum.

Nuclear Applications—As radiation shielding.

Rod, wire, and strip of the W-25 Re alloy are currently available from Chase. Users of significant quantities of rhenium are allowed price reductions of up to 15 per cent for pure rhenium and up to 80 per cent for Mo-Re and W-Re alloys.

Psychiatrist for Spaceman

Kenneth J. Hartman, experimental psychologist for the Space Biology Department at Aerojet-General Corporation, predicts the need for psychiatric help in space probably will be far greater than on earth.

The space demon that will cause much of the trouble is a thing called "sensory deprivation," the fact that man will be isolated from all the sights, sounds, and other senses he has had on earth.

Scientists have known about some effects of sensory deprivation for many years, in cases of persons isolated from normal sights and sounds for various reasons, such as shipwreck, lonely military duty, or even head or eye surgery.

And in test, they found that the person gets lonesome, hostile, bored—and gets serious and bizarre hallucinations. Here are just a few hallucinations reported after some Air Force tests:

"The rpm indicator seemed to have a little man, showing head and shoulders, in a sombrero, holding an umbrella overhead." "The place where the needle was connected began to look like little people." "I saw a miniature Spanish soldier in a silver helmet and yellow blouse and pantaloons."

So there is a predictable probability that the Spaceman will wind up on the psychiatric couch to report, "I dreamed I was a Martian in my made-in-America pressurized space suit."

And he'll be told, "You're not sick, you're just in space."

Nuclear Briefs

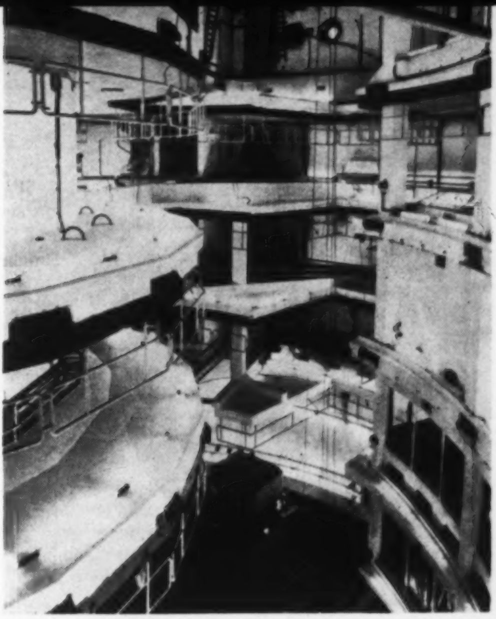
▶Buried Submarines

The Navy is studying the possibility of using obsolete submarine hulks as economic personnel shelters. Since they are entirely self-sustaining, submarines would give ideal protection during atomic, biological, or chemical attacks. The Navy is now evaluating the problems of modifying the submarines and placing them underground.

▶Belgian Reactor

Belgian Reactor No. BR-2, Europe's first major materials and engineering test reactor, went critical June 29, 1961. The United Nuclear Corporation designed and built the 50-mw water-cooled reactor at a cost of about $20 million.

The BR-2, located at Mol, Belgium, is one of the world's highest powered atomic experimental facilities. Its thermal neutron flux is 10^{15} neutrons per sq cm per sec and its fast flux is 2.5×10^{15} neutrons per sq cm per sec. Completion of BR-2 increases the nuclear materials and testing capability of the Free World by almost 50 per cent. The BR-2 will involve an operating staff of about 100 nuclear and related experts and will cost about $2,500,000 to operate annually.


Interior view of BR-2 reactor at Mol, Belgium. Control room is at upper left, reactor access balconies are on the right.

The European Atomic Energy Community (Euratom) will share in the operating costs. The entire project was financed by the Belgian Government.

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Materials Briefs

▶ New Ductile Superconducting Alloys Discovered

A series of new alloys made of molybdenum and technetium (technetium is a man-made element) has been discovered by Bell Telephone Laboratories.

Cryogenic experiments have shown that these new alloys, which are very ductile, become superconducting at temperatures higher than for any other alloy near 16 K. (Nb_3Sn, the superconductor with the highest known transition temperature, is a brittle compound.)

▶Silver Shortage

World consumption of silver has consistently exceeded mine production at a rate of about 67 million ounces annually over the past decade. The traditional markets of art materials and coinage have already been overtaken by industrial uses. All markets show every indication of substantially increasing.

Until now, the difference between consumption and production has been made up chiefly from the Treasury-held reserves. (It is available to all U.S. consumers at 91 cents per ounce.) But these reserves are virtually used up and the question is, "What happens when they are gone?"

According to an article in the June, 1961, issue of *News and Progress in Metals*, this will inevitably cause a sharp rise in the price of silver.

A shortage could have a critical effect on several key industries such as the photo industry, using 28–32 million ounces annually, and the electricial industry, using 18–20 million ounces annually. Mechanical engineering accounts for over 24 million ounces alone.

One solution lies with the U.S. Treasury. By selling silver at 91 cents it kept the U.S. silver price fixed. If the Treasury would gradually change to the coming free market the situation might be eased. A decision to sell silver at the market price instead of the fixed price would bring a modest price rise without invoking uncertainties as to immediate supply sources, and it would pave the way for orderly development of a stable market. Most industrial users of silver would find modest increases in silver prices far more tolerable than shortages and uncertain supplies.

▶Bearings Operated at 1000 F Without Normal Lubrication

Experimental rolling-contact bearings of carbides, ceramics, and other specially developed heat-resisting alloys, for possible use in missile, aircraft, and gas-turbine engines have been run at 1000 F and above—without normal lubrication. These extreme-temperature tests were made by SKF Industries' Research Laboratory over prolonged periods and with substantial loads and speeds.

"Conventional steel bearings would fail and normal lubricants burn away" under these conditions, according to Thomas W. Morrison, Mem. ASME, director of engineering and research.

▶Lead Comeback

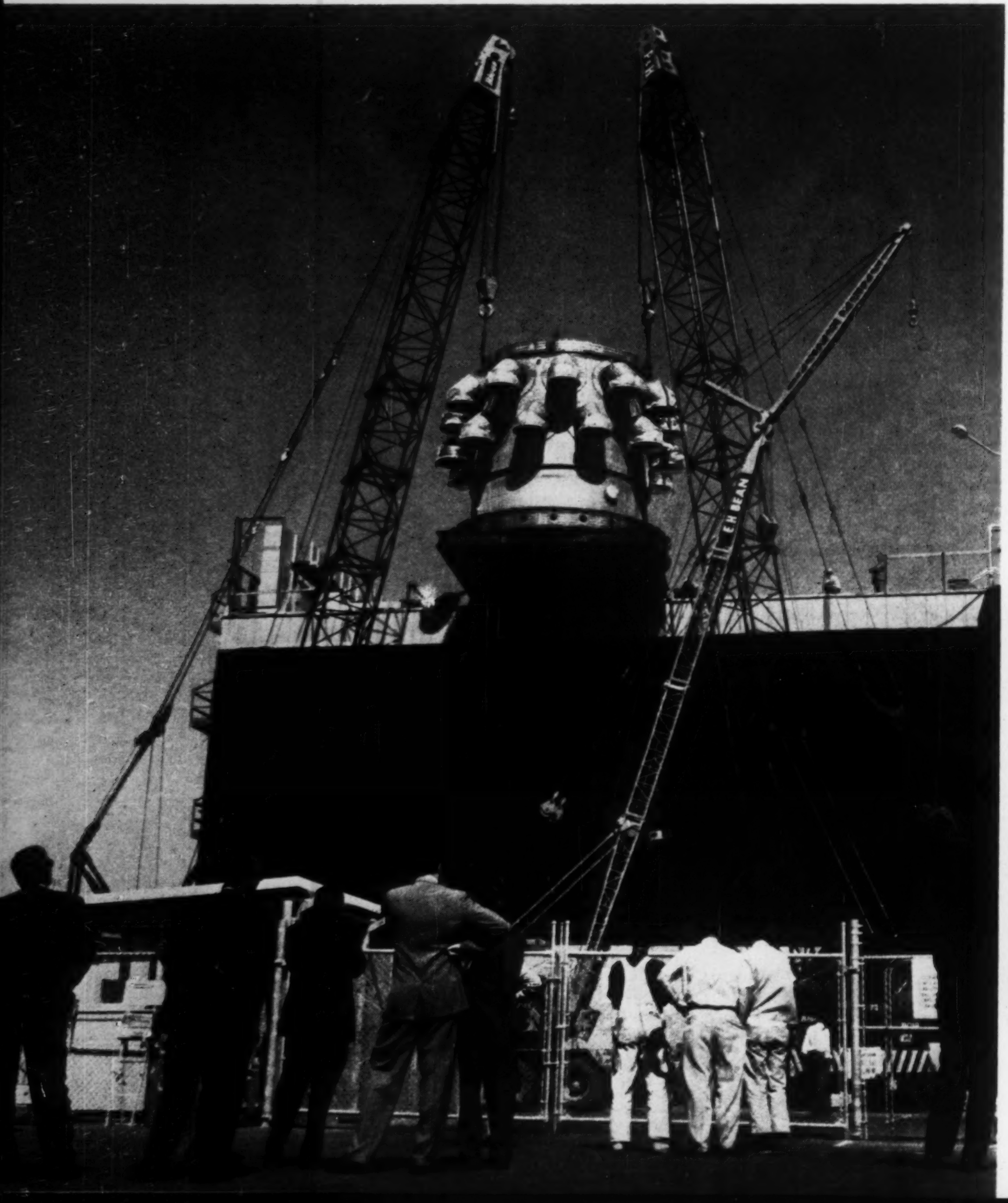
You can expect to see more lead linings being used in the chemical process equipment. Because industry failed to develop new fabricating techniques, lead temporarily lost its pre-eminence as a corrosion-resistant lining to newer and more aggressively marketed materials such as plastics, glass, and ceramics.

Of particular significance is the recent development, by Knapp Mills Inc., of a series of composite metals marketed under the trade name "Insmetals." They consist of a metallurgically bonded lead surface of unrestricted thickness applied to one or more of a wide range of base metals. Examples: Cupralum (copper and lead), Bauxilum (aluminum and lead), Ferrolum (carbon steel and lead). These materials have the advantages of lower initial cost than comparable materials, installation costs that are less or equal to competitive materials, and simple maintenance techniques.

PHOTO BRIEFS

M. BARRANGON

1 **SPACE CHAMBER.** A 55-ton satellite "space chamber" is lifted to the top of its specially constructed building at Lockheed Missiles and Space Company, Sunnyvale, Calif. The High Vacuum Orbital Simulator (HIVOS), 20 ft high and 18 ft diam, will accommodate a satellite 8 ft in diam and 15 ft long, simulating conditions 200 miles from the earth. Pumps can reduce the inside to a near-complete vacuum, and the sun's heat in space will be simulated by quartz lamps close to the satellite's outer surface. The stainless-steel chamber was built for Lockheed under contract with Consolidated Vacuum Corporation of Rochester, N. Y., the principal subcontract going to Puget Sound Bridge and Dry Dock of Seattle, Wash. 2 **LENS TUNNEL.** This is the way optical research looks in the new Kodak Research Laboratories' physics building at Eastman Kodak Company, Rochester, N. Y. Two physicists are testing a lens on an optical bench that extends the length of a 160-ft tunnel. The lens tunnel is located underground, outside the main foundations of the building, to minimize vibration and temperature variations.



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3 **PRECISION MEASUREMENT.** Shown gaging that transparent part is a precision measuring machine developed by the Sheffield Corporation, Dayton, Ohio, a subsidiary of Bendix. The machine is designed to gage inside and outside contours accurately, rapidly, and simultaneously. The part to be measured, such as a missile nose cone, rotates on the positioning table, while sensing devices "feel" the inner and outer surfaces, also recording the thickness. Contour and thickness data are typed automatically on the print-out unit. The system is capable of detecting part deviations in the order of 0.000010 in. 4 **STRESS, STRAIN, AND TEMPERATURE.** Developed at Battelle Memorial Institute, Columbus, Ohio, this VST (very short time) simulator tests the strength of metals at high temperatures. It simulates the sudden, intense heat and violent pushing, pulling, and twisting that place unprecedented demands on metals in aircraft and space vehicles. Tensile strength, creep, and relaxation can be studied at temperatures above 2000 F. Heating is by electricity, resistance of the specimen raising its heat to the desired temperature. This equipment is proving useful in evaluating the short-term strength built into metals by cold-working or special heat-treating. 5 **PORTABLE HARDNESS TESTER.** Carry your hardness tester to the metal: Check the hardness of large objects, including pieces with complicated contours. Radio Corporation of America's Industrial and Automation Division, Detroit, Mich., makes this portable instrument in which penetration causes voltage changes in the gage head, changes which are converted to a smoothly varying direct current proportioned to the depth of penetration. In addition to steel, the instrument can check soft metals such as aluminum or copper if the thickness is more than 0.6 mm.

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Engineering Progress in the British Isles and Western Europe

EUROPEAN SURVEY

J. FOSTER PETREE
European Correspondent

Fire-Extinguishing Powders

Uranium, plutonium, and thorium in the metallic form, when finely divided, can ignite spontaneously in air; thorium is particularly dangerous in this respect. Also, the uranium and plutonium oxides which could be produced and dispersed by such spontaneous combustion are more or less highly toxic. Metallurgists of the United Kingdom Atomic Energy Authority have produced a fire-extinguishing medium in the form of a eutectic mixture of dry powdered inorganic chlorides and/or fluorides, inert toward the metal involved. The composition is such that the melting point is below that of the burning metal. The powder therefore fuses in contact with the burning metal, forming a skin which excludes air and cooling the metal by absorption of latent heat. In a test of a powder of this type, where the ignited material was a light magnesium alloy for aircraft wheels, its effect was "spectacularly successful."

Strip Mill With Automatic Tensioning

Steel, Peech & Tozer, Ltd., Sheffield, England, whose hot-strip mill at Brinsworth, near Sheffield, was described in the May, 1959, "European Survey," have now installed adjacent to it a four-stand, four-high, tandem cold-rolling mill with controls of advanced design. The strip for cold rolling comes from the hot mill and, after pickling, is delivered in coil form to the cold mill through a tunnel from the pickling plant.

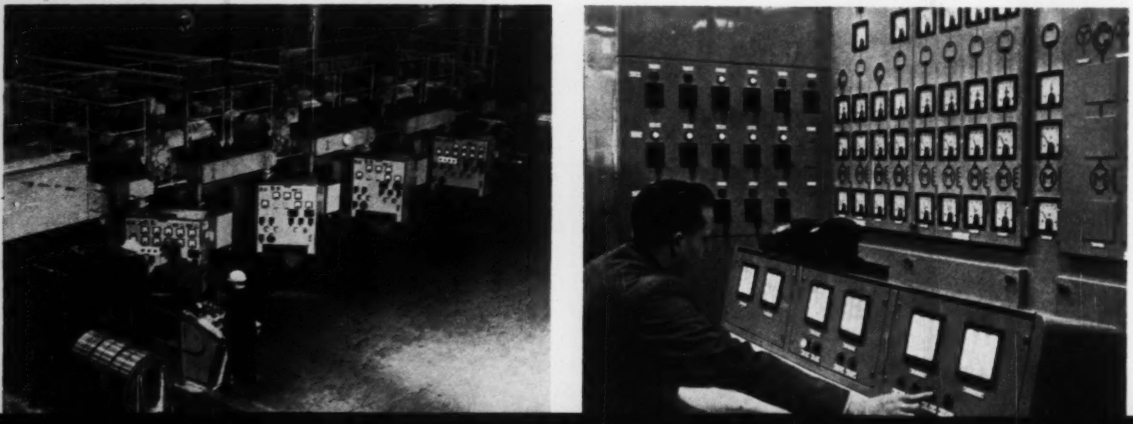
Stands 1 and 4 of the cold mill are fitted with automatic gage control, and there is automatic interstand tension control between stands 3 and 4. During the rolling the strip is not in contact with guides of any kind, but maintains its central position in the mill solely by means of the interstand tension, which is infinitely variable. Any deviation from straightness is indicated on panels at each stand, enabling immediate adjustment to be made, and any fault occurring during rolling operates an audible alarm and also a flashing illuminated alarm at the control desk in the motor room.

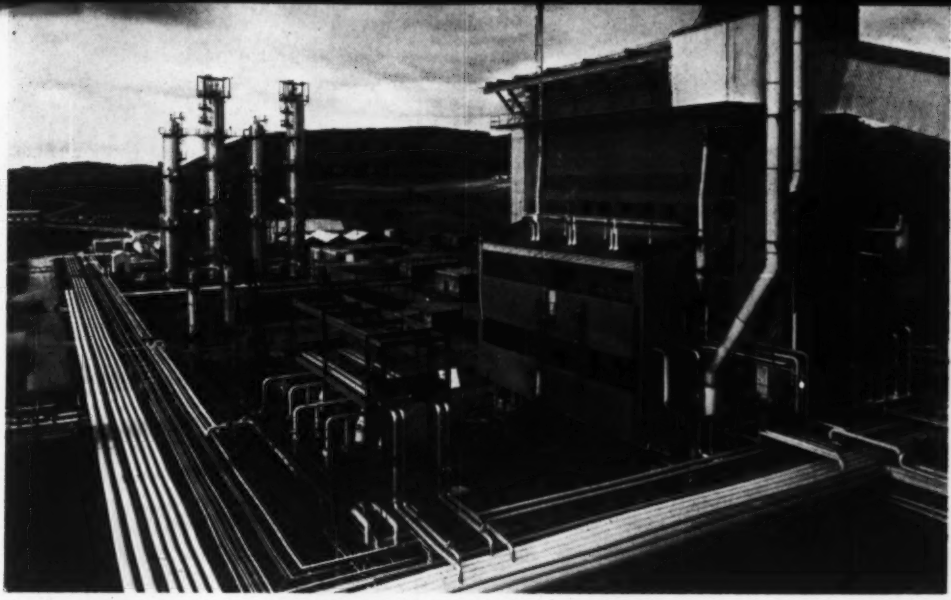
The mill motors, which have a combined rating of 4300 hp, are supplied from rectifier/inverter units which power the motors when rolling and return current to the supply line when the mill is decelerating—a feature believed to be unique in British rolling-mill practice. The mill is designed for a gage range from 0.010 in. to 0.160 in. and for strip widths from 4 in. to 18 in. All feeding and stripping operations are mechanized.

After rolling, the strip is annealed in two Nassheuer continuous furnaces, 290 ft long, with a capacity of 5 tons/hr each, into which the coils are fed by a tilting table serving both furnaces. Thence the coils go to a two-high temper mill, in which, as well as the desired temper, the strip can be given any surface finish from matt to a mirror finish. Finally, the coils go to the slitting section for trimming to exact width. The Brinsworth cold mill can deal with all qualities of steel, but is mainly employed in rolling low-carbon steels in all tempers.

Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

General view, **left**, of four-stand, four-high tension tandem cold-rolling mill at Steel, Peech & Tozer, Ltd., Sheffield, England, shows automatic gage control. The steel strip being rolled maintains its central position in the mill by means of automatic interstand tension control. Any deviation from straightness shows on panels. At **right** is fault-finding panel in motor room, where alarms warn of faults that occur during rolling.





View from boilerhouse of the Lurgi high-pressure complete gasification plant officially opened on June 27, 1961, by Queen Elizabeth II. It is located at Westfield in Fife, Scotland. Bounded by the pipebridge are the Lurgi house, **right**, and the Benfield towers. The gasifiers are inside the Lurgi house.

Lurgi Gas Plant for Scotland

The Lurgi process for the complete gasification at high pressure of low-grade noncaking coal was developed in Germany by the Lurgi Gesellschaft für Wärmetechnik m.b.H., of Frankfurt-am-Main, to make gas from brown coal. There are only three such plants in the English-speaking world; the first at Morwell, Victoria, Australia, built in 1956, and the second in South Africa. The third, at Westfield, Fife, Scotland, was officially opened on June 27, 1961, by Queen Elizabeth II.

The Westfield plant, which cost $18,500,000, produces at present 15 million cu ft of gas per day from an opencast coal which is quite unsuitable for gas-making by any other means. This output is expected to be doubled in a few months, and the plant will then be able to supply one fifth of the total gas requirement of Scotland. A high-pressure pipeline is being constructed to distribute it over an area of 4000 sq miles.

A mixture of washed coal, size $^1/_2$ in. to 1 in., and some shale of high-ash content from the washery, is delivered to the plant by rail and carried by conveyer belt to the gasifiers, three in number. The Lurgi gasifier is a fusion-welded mild-steel vessel 10-ft diam and 19 ft high. The coal enters through a lock-hopper at the top. Steam and oxygen at high pressure (426 psi) are introduced at the lower end and react with the coal to produce gas. Ash is withdrawn at the bottom through another lock-hopper. Normally, two gasifiers will be in use, with the third as a standby. Each has a capacity of $7^1/_2$ million cu ft per day.

Steam is supplied by two 45,000 lb/hr Babcock & Wilcox "Bi-drum" boilers at 450 psi and 730 F. As the coal burned has a high ash content and a large percentage of fines below $^1/_8$ in., they are fitted with "Ignafluid" grates, a French design working on the fluidized bed principle. The fine coal enters the furnace through a port in the front wall and falls onto a mechanical grate. A pulsating flow of air from below the grate holds the fuel bed in suspension. Some of the fine particles burn in suspension, but most are deposited on the furnace floor at each side of the grate, where they fuse. The semimolten ash flows back onto the grate and is carried to the back of the furnace, where it falls as clinker on the ash conveyer.

The oxygen is produced in a plant of the liquid-pump type, which compresses oxygen in the liquid state and delivers compressed gaseous oxygen. It operates by separating air into oxygen and nitrogen, the liquid oxygen being pumped at 426 psi and minus 183 C to a heat exchanger, from which it emerges as a gas, still at 426 psi. This is the first time that liquid-oxygen pumps have been used in a Lurgi plant. A reserve supply of 560 tons of liquid oxygen is kept in storage.

Crude gas leaves the gasifiers at 400 to 450 C and is cooled to about 196 C by spraying with tar water in a quench cooler. After further cooling, benzole is removed by washing with light oil, and CO_2 and hydrogen sulfide are extracted together in a "Benfield" hot potassium carbonate plant (so named for its inventors, Benson and Field, of Pittsburgh, Pa.). This plant has an absorption efficiency of over 90 per cent, but this is not enough to meet the statutory requirements for a public gas supply, so further purification is carried out in a Bischoff oxide plant. The purified Lurgi gas has a calorific value of 400 Btu/cu ft, which is below statutory requirements. It is therefore enriched by the addition of butane, bringing it up to 450 Btu/cu ft. The 12-in. distribution main so far constructed, across country to Glasgow and up north to Perth and Dundee, carries a pressure of 250 psi.

Oil Drilling Off Dutch Coast

Exploratory drilling for oil in the North Sea, off the coast of South Holland, is planned to begin this September, using the mobile underwater drilling platform "Triton," illustrated in the "European Survey" for June, 1960. The Triton belongs to a Dutch company, N.V. Nederlandsche Aardolie Maatschappij, in which Standard Oil of New Jersey and the Bataafsche Internationale Petroleum Maatschappij have equal shares, and for this purpose has been fitted with a helicopter platform. The drilling site is about $2^1/_2$ miles offshore near The Hague. Three helicopters based on an airfield near Rotterdam will serve the platform and will take the crew off in case of bad weather, which can develop quickly in these waters. It is expected that the bore will reach a depth of about 6500 ft.

Substance in
Brief of Papers
Presented at
ASME Meetings

KAREN SODERQUIST
Editorial Asst.

ASME TECHNICAL DIGEST

Process Industries

Cyclic Processes in Closed Regenerative Gas Machines Analyzed by a Digital Computer Simulating a Differential Analyzer..61—SA-21... By T. Finkelstein, Battelle Memorial Institute, Columbus, Ohio. 1961 ASME Summer Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to April 1, 1962).

Closed, reversible, regenerative gas engines can operate either as prime movers, heat pumps, or refrigerators and their ideal efficiency is equal to that of the Carnot cycle. An over-all thermal efficiency of 39 per cent has recently been claimed for a 40 horse power engine, and air liquefiers operating on this principle are gaining in popularity. Development was, however, severely hampered by a lack of understanding of the thermodynamic process in such machines. Experimental results were confined to a narrow range because most design changes could only be tested by the construction of a complete new prototype. This is possibly why the latest machines described in the literature are still identical in layout with an engine first invented nearly 150 years ago. The procedure described in this paper will allow a designer to compute electronically the effect of any change proposed before actually constructing a prototype.

A set of equations is given for the cyclic variations of temperatures, pressures, and flow rates in different parts of the system. A heat balance is set up for the integrated heat transfer and mechanical energy conversions per cycle and an accurate figure for the efficiency of prime movers or the Coefficient of Performance of heat pumps or refrigerators is derived from this. Special computational techniques simulating a differential analyzer on an IBM 704 electronic computer are described and the results of a typical practical case are given in graphs and figures.

Inertial Impaction in Cyclone Separators..61—SA-35... By M. H. Binark, University of Istanbul, Taksim, Turkey; and S. P. Patel, Assoc. Mem. ASME, Pennsylvania State University, University Park, Pa. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

A theoretical and experimental study of inertial impaction in cyclone separators is reported. The theoretical analysis assumes complete mixing of the mist with air. An expression for impaction efficiency is obtained. The cyclone was tested in a setup constructed to study inertial mist collectors. An oil mist was used to measure the impaction efficiency.

The drop-size distribution of the test aerosol was measured by means of a series impactor. The effects of inlet velocity and width of the cyclone inlet, drop-size distribution, and concentration of the test aerosol on the impaction efficiency were investigated. The magnitude and direction of tangential velocity distribution in the cyclone were measured with a hot-wire anemometer.

Closed Loop Control by Gas Chromatography..61—SA-48... By Edward E. Escher, Consolidated Electrodynamics Corporation, Pasadena, Calif. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

Gas chromatographs used for process control are automated versions of laboratory chromatographs which, in turn, apply a special version of the more general chromatographic principle. This is based upon a mixture by using a moving phase to flush a sample through a stationary phase bed having different affinities for different components in the sample. This difference in affinities means that the different components in the sample move at different rates, so that they emerge from the bed mixed with the moving phase, but separated from each other. They are then detected and measured by any method that will detect them quantitatively in a binary mixture with the moving phase; for example, thermal conductivity, density, refractometry, or infrared. Thermal conductivity is the method universally used in process chromatography.

In gas chromatography the moving phase is usually helium and the stationary phase is ground firebrick coated with a nonvolatile liquid called the partitioner. The stationary phase is packed in a length of $^1/_4$ or $^1/_8$-in. tubing called the column.

The principles and practical application of process chromatography to closed-loop control, and its relationship to computer control are discussed. Several existing applications are described, particularly from the economic standpoint.

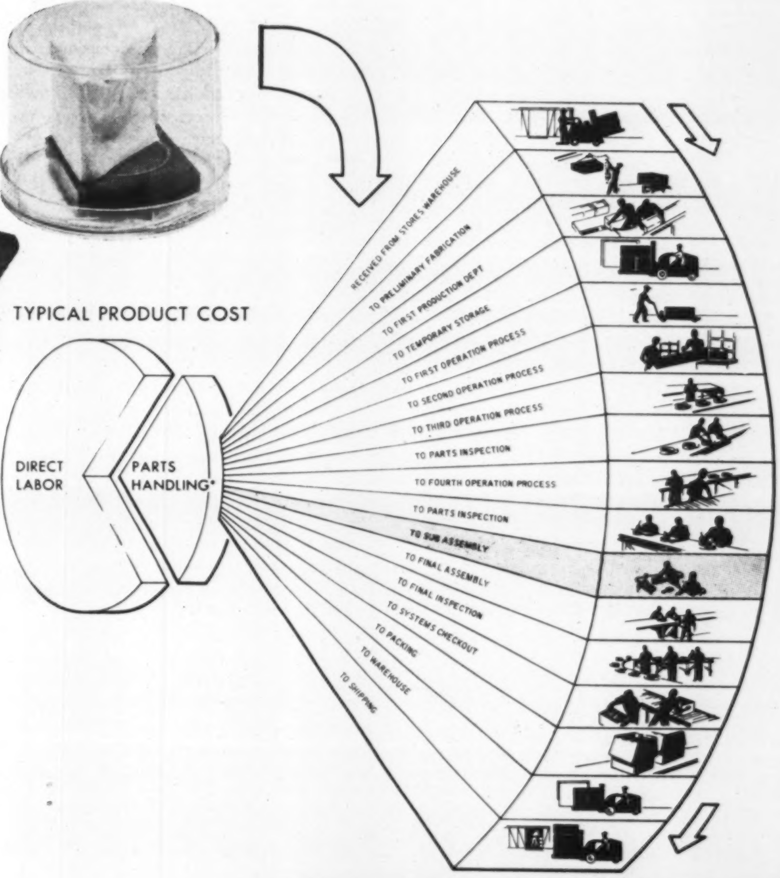
Saturated Steam Reheater Applied in New Nuclear Power Station..61—SA-47... By F. W. Gettler, Jr., Gibbs and Hill, Inc., New York, N. Y.; and J. H. Potter, Mem. ASME, Stevens Institute of Technology, Hoboken, N. J. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

The Enrico Fermi Station of the Societa Elettronucleare Italiana is an all-nuclear-powered, pressurized-water plant designed to add 176,000 kw to an existing electric power network. Moisture separation and reheating are included in the cycle. A steam-to-steam extended-surface reheater was installed between the high and low-pressure turbines, raising the working steam temperature into the superheat zone. This arrangement improves plant efficiency and increases turbine blade life at economic incremental cost.

Various cycles were studied in detail for all-nuclear-powered pressurized-water reactor systems for the Enrico Fermi Station. Five of these are presented to show the relative effectiveness of each of the modifications studied.

Clean packaging ▶

▼ Improperly packaged part unsuitable for opening in clean areas


TYPICAL PRODUCT COST
DIRECT LABOR
PARTS HANDLING*
RECEIVED FROM STORES WAREHOUSE
TO PRELIMINARY FABRICATION
TO FIRST PRODUCTION DEPT
TO TEMPORARY STORAGE
TO FIRST OPERATION PROCESS
TO SECOND OPERATION PROCESS
TO THIRD OPERATION PROCESS
TO PARTS INSPECTION
TO FOURTH OPERATION PROCESS
TO PARTS INSPECTION
TO SUB ASSEMBLY
TO FINAL ASSEMBLY
TO FINAL INSPECTION
TO SYSTEMS CHECKOUT
TO PACKING
TO WAREHOUSE
TO SHIPPING

Materials Handling

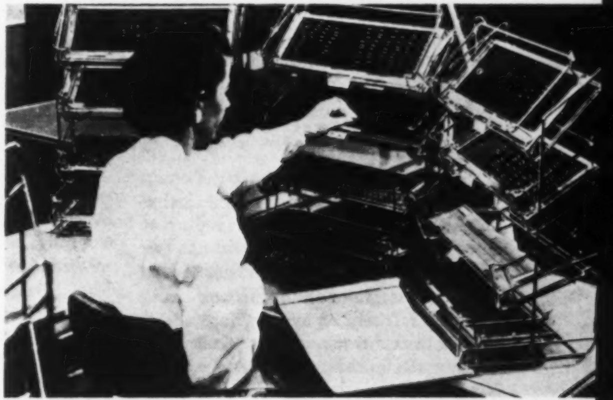
The Development of Protective-Handling Systems for High-Reliability Components and Systems..61—SA-16... By G. A. Peters, Autonetics, Division of North American Aviation, Inc., Downey, Calif. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

The development is described of a coordinated protective-handling system for high-reliability components and systems associated with the space era, and a concept is presented wherein protective-handling challenges are being met by (*a*) redirecting proper methods back into the supplier's plants, (*b*) applying protective methods throughout the manufacturing operation, and (*c*) utilizing protective packaging and shipping systems for the delivery of high-reliability products. Also discussed are some of the manufacturing techniques and requirements for the advancement of the state-of-the-art as related to protective devices developed during the past year.

The Automation of a 40,000 Ton Per Day Ore-Handling Facility..61—SA-8... By C. M. Marquardt, Industrial Physics and Electronics Company, Salt Lake City, Utah. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

The author describes a solution to the problem of handling 2500 tons per hr of crushed ore, conveying it to storage bins via a sampling plant, and removing this ore from storage bins automatically to fill nineteen 1000-ton mill bins. Ores are blended when removed from the storage bins to make a single copper ore for concentrator mill feed. The control system developed was designed to eliminate all man-power possible in the conveying, sampling, and reclaiming processes.

Under normal operating conditions the system is operated by the tower panel



Maintaining the high reliability of delicate components through protective packaging is becoming increasingly important to production organizations, especially those in fields such as electronics. Parts that have been properly packaged by the manufacturer can be absorbed easily and safely into the production and assembly processes of plants receiving them. With the use of toteboxes, carts, racks, and grid holders for loose parts, a plant with a complete protective handling program can further guard delicate components from the time of arrival at the plant through assembly and final shipment. Various phases in a parts-handling program are shown in the graph. Girl at assembly board illustrates the phase of subassembly (shaded area) as she selects various parts from protective-handling trays to make up a "Minute-man" circuit board (61—SA-16) operator and the concentrator panel operator with one man doing general clean-up and maintenance work, but available at the storage area.

Pitfalls in Air Conveying..61—SA-9... By Douglas L. Burrell, U. S. Industrial Chemicals Company, Tuscola, Ill. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

Described are factors for consideration by the user of an air conveying system for handling granules, pellets, and powders. Discussion covers available services from manufacturers; potential operation problems with conveyer elements; and, degree of system control. Some basic design practices and a brief discussion of fundamental systems are presented. Intent is to provide aid in: (*a*) Evaluating air conveying design, and (*b*) reducing general operating problems, rather than furnishing a basis for design.

A One Man Boom Hoist System for Handling Citrus Fruit..61—SA-10... By Roy J. Smith, University of California, Riverside, Calif.,; and Russell L. Perry, Mem. ASME, University of California, Los Angeles, Calif. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

The California citrus industry, together with other produce industries, has been searching for improved methods in the orchard handling of its fruit. The traditional method has been to use field boxes holding about 50 lb, carried on trucks. Improvements have been sought with systems using bulk trailers, bulk trucks, and trailers with demountable bins. Bins set down in the orchard have been handled by skip-loaders, fork trucks, lumber straddle trucks, and boom hoists. The boom-hoist system is described. In development for several years, it constitutes an attempt to achieve certain specific operational objectives.

The bin which is used in the boom-hoist system is small enough so that one can be filled by a picker without excessive carrying distances. This is particularly important for lemons where the yield per picking is often only a half box per tree. The bin is light for easy handling and nests when empty. The handling equipment is able to bypass containers which are set down beside the box road. Transport is on trailers, so that orchard operations can be handled at low speed, and highway hauling at high speed with separate tractive units, without bin transfer at roadside. The light farm tractor provides the better form of power in the orchard. The standard truck is the better tractive unit on the highway.

The field test program also described was planned to evaluate performance of critical elements of the system.

Tensions in Straight and Curvilinear Belt Conveyers..61—SA-11... By W. A. Winkler, Mem. ASME, Utah Construction and Mining Company, Palo Alto, Calif. 1961 ASME Summer Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to April 1, 1962).

This paper presents a simplified method of tension calculations in belt conveyers, suggesting the same approach regardless of whether belts are straight or curvilinear. A key diagram is introduced for the quick identification of critical tensions for all basic conditions.

It is common practice to use an analytical method for the calculation of tensions and horsepower of more complicated belt conveyers, especially curvilinear belt conveyers. The big advantage of this method is that it permits the establishment of tension values for the design of concave and convex curves and also for the design of drive and take-up when not located at conveyer ends. However, the so-called analytical method has a distinct disadvantage in practical engineering—it is time-consuming.

The purpose of this paper is to present a faster way to find all belt tensions necessary for the proper design or selection of conveyer components.

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Heat Transfer

Thermal Radiation Characteristics of Cylinder Enclosures..61—SA-23... By E. M. Sparrow, Assoc. Mem. ASME, and E. R. G. Eckert, Mem. ASME, University of Minnesota, Minneapolis, Minn.; and L. U. Albers, NASA Lewis Research Center, Cleveland, Ohio. 1961 ASME Summer Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to April 1, 1962).

Consideration is given to the radiant interchange within finite-length cylindrical holes, one end of which is open to the environment. The bounding surfaces of the hole are isothermal and radiate in a gray, diffuse manner. The problem is analyzed by applying radiant flux balances to infinitesimal elements of surface, and this gives rise to two simultaneous integral equations. The solutions to these provide such technically interesting results as the distribution of the apparent emissivity and local heat flux along the bounding surfaces and, also, the over-all heat flux streaming from the hole.

It is found, for example, that to achieve an apparent emissivity of 0.99, the minimum length of hole is 1.6, 2.6, or 4 diameters depending on whether the surface emissivity ϵ is 0.9, 0.75, or 0.5. The over-all heat loss results demonstrate the effect of the presence of pits and depressions in increasing the heat loss from a surface.

Thermocouple Temperature Disturbances in Low Conductivity Materials..61—SA-27... By James V. Beck, Assoc. Mem. ASME, Avco Corporation, Wilmington, Mass. 1961 ASME Summer Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to April 1, 1962).

The axisymmetric transient heat conduction problem of a thermocouple embedded in a low thermal conductivity material is analytically investigated. The thermocouple is positioned normal to a surface heated by a time-variable heat flux. The results of the analysis are presented as dimensionless curves for a variation of several dimensionless parameters. The analysis may be used to calculate:

1 The temperature of a thermocouple temperature measurement for a known heat flux.

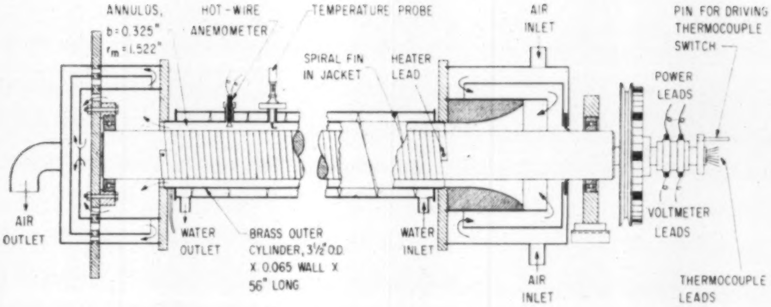
2 The undisturbed temperature at the location of the thermocouple junction from the transient thermocouple measurement.

3 The undisturbed heat flux just before thermocouple from the thermocouple measurement.

It is found that the temperature disturbances in the thermocouple reading due to the presence of the thermocouple itself may be very large. It is shown that in certain cases the disturbance could be as large as 50 per cent of the temperature rise. An example is given in which the disturbance reaches 700 F.

Heat Transfer for Pulsating Laminar Duct Flow..61—SA-28... By R. Siegel, Mem. ASME, and M. Perlmutter, Lewis Research Center, NASA, Cleveland, Ohio. 1961 ASME Summer Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to April 1, 1962).

Heat-transfer solutions have been obtained for pulsating laminar flow between parallel plates. The pulsations are caused by superposing an oscillating pressure gradient on the steady driving pressure of the flow. Two types of heat-transfer boundary conditions are considered: (*a*) The channel walls are at constant temperature; or (*b*) a specified uniform heat flux is transferred at the walls. The heat-transfer behavior is obtained along the entire length of the channel, that is, in both the thermal entrance and fully developed regions. The temperature distributions are two-dimensional, but a slug flow (one-dimen-



Details of apparatus for investigating those variables which control the rate of heat transfer in the air gap of a simulated electrical machine (61—SA-19)

sional) assumption is used to simplify the velocity distribution. The results are compared with those obtained using a quasi-steady assumption.

The Effect of Subcooled Liquid on Laminar Film Boiling..61—SA-29...By E. M. Sparrow, Assoc. Mem. ASME, University of Minnesota, Minneapolis, Minn.; and R. D. Cess, Assoc. Mem. ASME, North Carolina State College, Raleigh, N. C. 1961 ASME Summer Annual Meeting paper (in type; to be published in Trans. ASME—J. Heat Transfer; available to April 1, 1962).

When a heating surface immersed in a liquid is maintained at a sufficiently high temperature, there results a boiling process in which a vapor film completely envelops the surface. Such a process is usually called film boiling. In the absence of a forced flow in the liquid, all motions are induced by gravity forces.

Heat-transfer results for film boiling in the presence of a subcooled liquid have been determined analytically for the case of the isothermal vertical plate. The two-phase flow and heat-transfer problem that arises has been formulated exactly within the framework of boundary-layer theory, and free convection within the liquid has been accounted for. At a fixed temperature difference between surface and saturation, the effect of subcooling is to increase the heat transfer from the plate surface, with the magnitude of the increase being controlled by five physical parameters. Graphical presentation of the heat-transfer results is made for parametric values which correspond to water, but this information may be applied to other fluids having similar parameter ranges. For large subcooling, the heat transfer is essentially equal to that for pure free convection (no boiling), and the limits for this condition are given.

Entrance Effects in a Two-Phase Slug Flow..61—SA-30...By R. Moissis, Assoc. Mem. ASME, and P. Griffith, Assoc. Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1961 ASME Summer Annual Meeting paper (in type; to be published in Trans. ASME—J. Heat Transfer; available to April 1, 1962).

One stage of the flow development process in equipment working with two-phase mixtures is quantitatively described.

The kinetics of a Taylor bubble, as it rises behind a series of other bubbles in a gas-liquid slug flow, have been determined. The rise velocity of a bubble is expressed as a function of separation distance from the bubble ahead of it.

Using this information, the pattern of development of bubbles that initially enter a tube at regular intervals is determined by means of finite difference calculations. The density and, to a first approximation, the pressure drop of the developing flow are then calculated from continuity considerations. The density distribution in the entrance region is found to be a function of flow rates of the two phases, of distance from the inlet, and of initial bubble size.

Density calculated by the present theory is compared with experimental measurements by the present and other investigators. Theory and experiments are in good agreement.

Measurements of Diabatic Flow in an Annulus With an Inner Rotating Cylinder..61—SA-19...By K. M. Becker, Swedish Atomic Energy Company, Stockholm, Sweden; and Joseph Kaye, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1961 ASME Summer Annual Meeting paper (in type; to be published in Trans. ASME—J. Heat Transfer; available to April 1, 1962).

This paper is part of the second phase of an investigation of the phenomena and variables that control the rate of heat transfer in the air gap of a rotating electrical machine. Experimental data for diabatic flow in an annulus are summarized and compared with the results of previous studies. The data are examined in terms of the types of flow processes occurring in an annulus, and it is found that the results for diabatic flow clearly confirm those obtained for adiabatic flow in showing the existence of three, and possibly four, modes of flow in this annulus. These modes are: (*a*) laminar flow; (*b*) laminar-plus-Taylor-vortexes flow; (*c*) turbulent flow; (*d*) turbulent-plus-vortexes flow.

The heat-transfer data are subdivided into the following two limiting cases and one general case:

1 Case A—Axial flow with zero rotation.

2 Case B—Rotation of inner cylinder with zero axial flow.

3 Case C—General case of combined axial flow and rotation.

The heat-transfer data from this study and previous investigations are correlated in terms of Reynolds number and Taylor number over a wide range of these variables in terms of fairly simple equations.

Radial temperature profiles in the annular gap are measured for the diabatic flow and aided in the understanding of the different flow phenomena in the annulus with an inner rotating cylinder.

Analysis of Film Boiling on Vertical Surfaces..61—SA-31...By J. C. Y. Koh, Assoc. Mem. ASME, Boeing Airplane Company, Seattle, Wash. 1961 ASME Summer Annual Meeting paper (in type; to be published in Trans. ASME—J. Heat Transfer; available to April 1, 1962).

The two-phase flow problem in laminar film boiling on a vertical flat plate is analyzed. The shear stress and vapor velocity at the vapor-liquid interface are taken into account. The problem is treated by solving simultaneously the boundary-layer equations for the vapor and liquid phases. In contrast to the film-condensation problem where the heat transfer is independent of the $\rho\mu$ ratio, and where the interfacial shear can be neglected for a Prandtl number of unity or larger, it is shown that the $\rho\mu$ ratio is an important parameter in the film-boiling heat transfer, and that the interfacial shear is quite different from zero.

Laminar Flow Heat Transfer for Variable Physical Properties..61—SA-32...By L. B. Koppel, California Institute of Technology, Pasadena, Calif.; and J. M. Smith, Northwestern University, Evanston, Ill. 1961 ASME Summer Annual Meeting paper (in type; to be published in Trans. ASME—J. Heat Transfer; available to April 1, 1962).

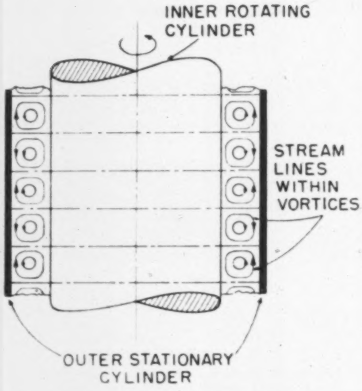
A solution is presented for heat transfer from a circular tube to a fluid, with variable properties, in fully developed laminar flow within the tube. The major assumption employed is that the radial velocity component may be neglected. The method is illustrated for supercritical carbon dioxide with the boundary condition of constant wall heat flux. Under these conditions the density and thermal properties vary greatly with temperature. The results indicate that unusual behavior of the heat-transfer coefficient may occur for certain values of heat flux and fluid temperature. The new solution technique presented should be applicable to a variety of partial differential equations with variable coefficients.

The Development of Free Convection Between Heated Vertical Plates..61—SA-33... By J. R. Bodoia, Bettis Atomic Power Division, Westinghouse Electric Corporation, Pittsburgh, Pa.; and J. F. Osterle, Assoc. Mem. ASME, Carnegie Institute of Technology, Pittsburgh, Pa. 1961 ASME Summer Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to April 1, 1962).

The development of free convection in a viscous fluid between heated vertical plates is investigated. The basic governing continuity, momentum, and energy equations are expressed in finite difference form and solved numerically on a digital computer. Results are obtained for the variations of velocity, temperature, and pressure throughout the flow field, assuming the fluid to enter the channel with ambient temperature and a flat velocity profile. The flow and heat-transfer characteristics of the channel are studied and a development height established. A comparison is made between the results of this theoretical investigation and the experimental work of Elenbaas.

Transient, Laminar, Combined Free and Forced Convection in a Duct..61—SA-25 ... By S. L. Zeibert, Assoc. Mem. ASME, City College of New York, New York, N. Y.; and W. K. Mueller, Mem. ASME, New York University, New York, N. Y. 1961 ASME Summer Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to April 1, 1962).

Transient, laminar, combined free, and forced convection in a duct is analyzed under the asumptions of constant fluid properties, and fully developed flow. The transient heating is taken to be a result of wall temperature variations; the wall temperatures vary linearly with the axial co-ordinate of the duct (this is shown to be the only permissible axial dependence, other than no wall temperature variation in the axial direction). Numerical results show that for certain combinations of the Prandtl and Rayleigh numbers, an oscillatory approach to steady state exists. This phenomenon can induce a large reduction of the Nusselt number (compared to steady state) during the transient period.



At a critical speed, laminar flow breaks down and a steady secondary flow is created in the form of pairs of counterrotating toroidal-shaped vortexes (61—SA-20)

The Influence of a Radial Temperature Gradient on the Instability of Fluid Flow in an Annulus With an Inner Rotating Cylinder..61—SA-20... By K. M. Becker, Swedish Atomic Energy Company, Stockholm, Sweden; and Joseph Kaye, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1961 ASME Summer Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to April 1, 1962).

The problem of instability of diabatic flow between rotating, concentric cylinders is studied analytically. The basic equations are reduced to a form identical to that of a similar instability fluid flow problem, namely, the instability of a horizontal layer of fluid heated from below. The latter problem has been solved by Pellew and Southwell, and their solution used to calculate and predict the instability of diabatic flow in the annulus. The results of the analysis show that heating of the inner rotating cylinder stabilizes the flow, while heating of the outer stationary cylinder destabilizes the flow.

Forced Convection Heat Transfer From a Uniformly Heated Sphere..61—SA-26... By W. S. Brown, Assoc. Mem. ASME, Utah Research and Development Company, Salt Lake City, Utah; C. C. Pitts, Student Mem. ASME, and G. Leppert, Mem. ASME, Stanford University, Stanford, Calif. 1961 ASME Summer Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to April 1, 1962).

An approximate analytical solution is presented for the variation of the local heat-transfer coefficient over the forward half of a uniformly heated sphere. Experimental measurements with water over a Reynolds number range of 5000 to 480,000 and a Prandtl number range of 2.2 to 6.8 give local coefficients that are in good agreement with analytical results. Average heat-transfer coefficients for the uniformly heated sphere are slightly higher than similar results reported earlier for an isothermal sphere. The effect of variations of heat flux on the average heat-transfer coefficient is correlated in a manner similar to that used for the isothermal data. Three different duct sizes were used in the experiment to determine the effect of this variable, and the correlations presented are based on duct-to-sphere diameter ratios of 2, 2.67, and 4.

Techniques for Optimization of a Finned-Tube Radiator..61—SA-44... By L. H. Schreiber, R. P. Mitchell, G. D. Gillespie, and T. M. Olcott, Convair-Fort Worth, Division of General Dynamics Corporation, Fort Worth, Texas. 1961 ASME Summer Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to April 1, 1962).

Power plants and cooling systems operating in space must utilize either an expendable heat sink, or radiation to space to reject waste heat. If the vehicle is to remain in space for a long period of time, the weight of expendable coolant becomes prohibitive, necessitating the use of a radiator. Since the radiator will probably be the heaviest component in the power-generating or cooling system, it is highly desirable to minimize radiator weight.

The radiator configuration of greatest interest is the finned-tube radiator. This type of design reduces the area vulnerable to meteoroid penetration and allows an increase in the heat rejection per unit of radiator weight over plain tubes.

The analysis presented provides a method of optimizing, for the maximum Q/W, a rectangular cross-sectioned fin for use on a space radiator, considering the effects of both fin and tube. The data required for calculations are presented in graphic form. A comparison is made of beryllium, aluminum, and copper fins on beryllium and steel tubes. The consequences of meteoroid protection devices are also discussed.

Velocity and Temperature Profiles in Turbulent Boundary Layers With Tangential Injection..61—SA-24... By R. A. Seban, Mem. ASME, and L. H. Back, University of California, Berkeley, Calif. 1961 ASME Summer Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to April 1, 1962).

Velocity and temperature profiles are presented for the turbulent boundary layer downstream of a tangential injection slot for the further clarification of the film-cooling problem. The profiles refer primarily to an injection mass velocity of 0.36 times that of the free stream; these and other auxiliary results demonstrate a complex hydrodynamic and relatively simple thermal behavior in which the temperature profiles appear to be similar in all cases. By using this correspondence together with the approximation of a fully developed hydrodynamic layer in most of the downstream region, it is possible to rationalize the adiabatic wall temperatures that have been presented previously.

Heat Transfer by Simultaneous Conduction and Radiation in an Absorbing Medium..61-SA-34.. By R. Viskanta, Assoc. Mem. ASME, Argonne National Laboratory, Argonne, Ill.; and R. J. Grosh, Assoc. Mem. ASME, Purdue University, Lafayette, Ind. 1961 ASME Summer Annual Meeting paper; (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to April 1, 1962).

Heat transfer by simultaneous conduction and radiation in a thermal radiation absorbing and emitting medium is considered. Consideration is given to a one-dimensional system consisting of two, diffuse, nonblack, infinite, isothermal, parallel plates separated by a finite distance. The space between the plates is filled with a thermal radiation absorbing and emitting medium. The problem is formulated in terms of a nonlinear integro-differential equation and the solution is obtained by reducing it to a nonlinear integral equation. The numerical results are obtained by an iterative method. The temperature distributions and heat transfer are calculated. Two approximate methods for formulating radiant heat-transfer problems are presented.

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Production Engineering

Metal-Cutting Analysis—I: Re-Evaluation and New Method of Presentation of Theories..61—Prod-1... By S. Kobayashi and E. G. Thomsen, Mem. ASME, University of California, Berkeley, Calif. 1961 ASME Production Engineering Conference paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to March 1, 1962).

The orthogonal metal-cutting process is reanalyzed and the several existing theories are discussed. Alternate methods of presentation of the theories are derived in terms of energy ratios and are shown graphically in the paper.

A comparison of experimental data with theory reveals that none of the solutions account for all the experimental facts. From the discussion of the several theories that have been proposed it appears that the principal factor for determining the steady-state configuration in metal cutting seems to be the condition which links shearing and friction processes and this condition may be closely related to the phenomenon of chip-curl and to the size of the area of tool-chip contact. A new representation of equilibrium conditions for the chip is given in graphical form. This method of representation emphasizes the relationship of energy of cutting to the cutting angles.

Metal-Cutting Analysis—II: New Parameters..61—Prod-2... By S. Kobayashi and E. G. Thomsen, Mem. ASME, University of California, Berkeley, Calif. 1961 ASME Production Engineering Conference paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to March 1, 1962).

The orthogonal metal-cutting process is studied. It is found that the Ernst and Merchant solution, through the application of the limit-load theorems, appears to be a limiting solution for all cutting conditions. A new angle relationship is developed from energy considerations and it is found that the new parameters, effectiveness η and machinability factor ξ permit a better understanding of the machining process. It is found further that machining forces and power can now be predicted when the effectiveness η, the constant dynamic shear strength τ_s of the work material, and the chip ratio r or the friction angle β are known.

Flank Friction Studies With Carbide Tools Reveal Sublayer Plastic Flow..61—Prod-3... By E. G. Thomsen, Mem. ASME, and S. Kobayashi, University of California, Berkeley, Calif.; and A. G. MacDonald, Aeronutronics Space Technology Operations, New Port Beach, Calif. 1961 ASME Production Engineering Conference paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to March 1, 1962).

Orthogonal cutting tests with artificial flank-wear lands were performed on steel SAE 1112 as-received (cold-drawn), steel SAE 4135 as-received (cold-drawn), aluminum alloy 6061-T6 (extruded), and alpha-brass as cold-drawn. Forces, workpiece temperature, average tool temperatures, and other pertinent data were taken. Each test was of short duration (approximately 10 revolutions of the workpiece or less) and the tools were reconditioned between each test run.

The results show that, for steel SAE 1112, steel SAE 4135, and aluminum alloy 6061-T6, sublayer flow appears to take place when the flank wear-land clearance angle is set to a negative angle of magnitude −1 deg and the land is approximately 0.010 to 0.020 in. long. The condition for sublayer flow is predictable based on the state of plastic deformation and the stress-strain properties, at temperature and at appropriate strain rates for these materials.

Free Machining Steel—IV: Tools With Reduced Contact Length..61—Prod-4... By E. Usui and M. C. Shaw, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1961 ASME Production Engineering Conference paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to March 1, 1962).

Tools that provide controlled contact on the tool face are used to study the action of free machining steels. The mean normal stress on the tool face σ_c is found to increase with increased undeformed chip thickness (t = feed) or with a reduction in the controlled length of tool face contact. An increase in σ_c in turn is found to promote the stability of the built-up edge to higher speeds. The high-speed finish produced with a cutaway tool is thus found to be inferior to that produced with a conventional tool. Manganese sulfide is found to have a similar effect on surface finish, but lead tends to improve the finish obtained at a high cutting speed. The cutaway tool provides improved low-speed finish in all cases as does the addition of either manganese sulfide or lead to the steel.

Manganese sulfide is found to become more effective with increased undeformed chip thickness t, while lead behaves in the opposite manner. This observation along with several others is in agreement with the idea that manganese sulfide is a poor solid "lubricant" while lead is an effective solid lubricant.

An optimum chip-tool contact length appears to exist at which the tool life will be a maximum at any combination of cutting speed and feed. From this it follows that an optimum combination of sulfur or lead content, degree of cold work, cooling capacity of cutting fluid, or extent of tool-face limitation exists, since all of these quantities influence the resultant length of contact between chip and tool.

A Graphical Analysis of Regenerative Machine Tool Instability..61—Prod-5... By J. P. Gurney and S. A. Tobias, University of Birmingham, England. 1961 ASME Production Engineering Conference paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to March 1, 1962).

A graphical method for the investigation of regenerative machine tool chatter is presented. The method is based on the harmonic response locus of the machine tool structure and allows the determination of the stable and unstable cutting speed ranges. The chip thickness variation effect as well as the penetration rate effect are taken into consideration.

The method is illustrated by a number of examples relating to drilling or spot facing chatter arising on a radial drilling machine. The effects of mode interaction and of the penetration rate on the stability and on the variation of the chatter frequency are discussed. A critical assessment of the method is presented, in comparison with other methods available.

Strain Rate Distribution During Experimental Metal Rolling..61—Prod-6... By K. S. Yajnik and J. Frisch, Mem. ASME, University of California, Berkeley, Calif. 1961 ASME Production Engineering Conference paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to March 1, 1962).

Rolling of metals as an industrial process consists of passing a billet, sheet, or strip between rollers to reduce its thickness. In general, the torque is applied to the rollers and a pull exerted on the strips at the entrance or exit side or both. The rolling process where no driving torque is applied to the rolls and tension is applied to the exit side of the strips is known as steckel rolling and is the one used in the experiments described in this paper.

Plastic deformation in commercially pure lead strips during torque-free rolling is investigated. The experimentally determined slip-line field is compared with the theoretical solution of a similar problem and found to be different, having a plastic-rigid boundary with inflection points at the entrance section. It is observed that plastic deformation occurs well ahead of the initial contact point between the strip boundaries and the roll surfaces.

Comparative Effect of Land and Crater Wear on Tool Life When Dry Cutting, Mist Cooling, and Flood Cooling..61—Prod-7 ...By D. Kececioglu, Mem. ASME, and A. S. Sorensen, Jr., Assoc. Mem. ASME, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. 1961 ASME Production Engineering Conference paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to March 1, 1962).

Tool life is usually based on land wear alone. This could be misleading, particularly when cutting at high speeds with carbide tools, because then crater wear predominates. If the tool and the cutting conditions are selected on the basis of land wear alone, failure of the tool may occur before the permissible land wear is reached because of excessive crater wear. To avoid this possibility, both land and crater wear data should be acquired and then superposed. From such a plot the cutting conditions under which either land or crater wear governs tool life can be established.

Land and crater wear data, obtained when machining SAE 1045 hot-rolled steel with Kennametal type KM carbide-tipped tools and with air, flood, and mist as cutting media, are presented. The volume of workpiece material which has to be removed to attain an average land width of 0.030 in. and a maximum crater depth of 0.010 in. is plotted versus the cutting speed. From these results the conditions of cutting speed and medium at which either land or crater wear governs tool life are established, as well as the cutting medium which permits the removal of the greatest volume of workpiece material at a given cutting speed.

Use of Abrasive Belts and New Applications..61—Prod-9... By D. H. Knapp, Jr., The Carborundum Company, Niagara Falls, N. Y. 1961 ASME Production Engineering Conference paper (multilithographed; available to March 1, 1962).

New markets for abrasive-belt applications are continually being pursued with method and development work. The new markets being discovered include both metallic and nonmetallic industries as well as the ceramic and masonry field. New markets that were previously believed impractical and unknown are now accessible and new applications and methods are being applied. Other fields are in sight with still further development work and newer products are being developed to meet the challenge.

How to Verify an Optical Instrument's Accuracy..61—Prod-11... By A. W. Young, Engis Equipment Company, Chicago, Ill. 1961 ASME Production Engineering Conference paper (multilithographed; available to March 1, 1962).

Important factors to consider when determining the accuracy of an instrument are (*a*) the stability of temperature, which may be a cause of considerable error if any changes take place during the day, or during the time that the test is being conducted, (*b*) and the human factor.

The ability of an operator and the conditions under which the operator is working have a great deal to do with the accuracy of determination of the instrument. It is extremely difficult to get valid readings and positive results when operating under strain. The author advises how to proceed in determining the accuracy of many types of instruments.

The discussion covers instruments in general everyday use, such as block levels, engineers' levels, microalignment telescopes, scales and projectors, autocollimators, theodolits, polygons, and several new concepts involving flatness.

How to Measure Machine Tool Capabilities..61—Prod-10... By R. B. Nottingham and James Ralph, North Electric Company, Galion, Ohio. 1961 ASME Production Engineering Conference paper (multilithographed; available to March 1, 1962).

Wide interest is being shown in the subject of machine capability by the designer, the manufacturing engineer, manufacturing supervisor, and the quality-control engineer. The paper demonstrates a practical down-to-earth method for getting objective measurements of the capabilities of the machine tools in any shop.

Two basic types of analysis are employed. One is a graphic analysis which can indicate cycling tendencies and trends, and the second is a statistical analysis which indicates the statistical limits.

Some of the principal factors affecting machine capability are (*a*) machine and condition, (*b*) operation, (*c*) tooling, (*d*) speed, (*e*) feed, (*f*) coolant, (*g*) material, and (*h*) environment.

On Determining the Hardness of Grinding Wheels—I..61—Prod-8... By L. V. Colwell, Mem. ASME, University of Michigan, Ann Arbor, Mich.; R. O. Lane, Macklin Company, Jackson, Mich.; and K. N. Soderlund, University of Michigan Research Institute, Ann Arbor, Mich. 1961 ASME Production Engineering Conference paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to March 1, 1962).

A new method for evaluating the hardness of grinding wheels has been developed. It involves crushing small amounts of abrasive from the surface of a grinding wheel while in rolling contact with a hard steel wheel. Measured reaction forces provide a sensitive indication of significant variations in the hardness as well as other important properties of bonded abrasives.

A laboratory analysis of the method demonstrates that the hardness values incorporate the same elastic constants that have been shown to be important in actual grinding. The analysis shows also that it is feasible to establish a universally applicable industrial standard for grinding wheel hardness.

The method is valuable also as a research tool and may be expected to aid in producing more uniform abrasive products and to yield information that will help improve practices in the manufacturing plant.

On the Benefits of High Modulus-High Density Boring-Bar Structures..61—Prod-13... By W. L. Kennicott, Mem. ASME, and J. J. Galimberti, Assoc. Mem. ASME, Kennametal Inc., Latrobe, Pa. 1961 ASME Production Engineering Conference paper (multilithographed; available to March 1, 1962).

Chatter and vibration present in the

chip-making process can be attributed individually or in any possible combination to the cutting tool, the machine tool, the workpiece, and/or their environment. This paper then considers the problem of the cutting tool and is a preliminary study of the benefits that can be derived from making this tool, particularly boring bars, from a material of high Young's modulus and high density. It is also a preliminary study of various methods of construction to reduce deflection, chatter, and vibration and to increase the damping properties.

The following simple laboratory tests using various boring-bar materials and design configurations, with the use of strain gages, were conducted:

1 A standard commercial steel boring bar and an equally standard commercial carbide boring bar, having identical adjustable heads, were used to determine the relative strain and vibration which resulted when used under normal and identical boring conditions. An additional but similar test procedure using the same boring bars and strain gages but with a different amplification and recording system, provided strain (deflection) and chatter results.

2 A slightly more involved but still basic series of tests were conducted using the "simulated" boring bars or test specimens of $^3/_4$ in. diam by 18 in. long clamped in two V-blocks in a hydraulic press at one end to provide a 14-in. overhang.

3 A third test setup was made to evaluate the relative amplitude of vibration and damping decay rate of the same six specimens.

Diamond Cutting Tools Engineered for Production..61—Prod-14... By Jan Taeyaerts, Precision Diamond Tool Company, Elgin, Ill. 1961 Production Engineering Conference paper (multilithographed; available to March 1, 1962).

The merits of diamond cutting tools are very well known. Their ability to produce the smoothest, mirrorlike surfaces, highest precision tolerances, and their high productivity on very abrasive materials, has been demonstrated on many occasions. The purpose of this paper is not, therefore, to promote diamond turning as such, but to elaborate on the tool geometry, use, and care of diamond cutting tools so that even greater benefits may be derived from them.

The author warns that diamonds should be used on good, solid, fast machine tools—any vibration will shorten tool life considerably—and that a diamond should never be brought into contact with the work in a stationary position, nor should the machine be stopped in the cut. Too low cutting speeds are associated with diamond failure.

Optical Check Out of Large Machine Tools..61—Prod-15... By George W. Donald, General Electric Company, Pittsfield, Mass. 1961 ASME Production Engineering Conference paper (multilithographed; available to March 1, 1962).

At the Ordnance Department in Pittsfield, it has been found that on some of the machine-tool alignment checks, reliance can no longer be placed on straight edges, squares, levels, and indicators. Straight edges tend to conform to the parts being checked; squares are no better than the surface they rest on; levels only show local conditions; and indicators are not very reliable when readings are taken in more than one position, such as sweeping a square. Hence, optical equipment is used in aligning lathes, milling machines, jig borers, vertical boring mills, planers, large grinders, horizontal boring mills, and so on. In this paper horizontal boring-mill alignment will be discussed. It is concluded that any machine properly aligned produces better parts with less effort and that, when using a tape-controlled machine, proper alignment is absolutely necessary because positioning accuracy is dependent upon machine alignment.

Management Operating System..61—Prod-19... By R. N. Easun and R. C. Carroll, International Business Machines Company, Ltd., Toronto, Canada. 1961 ASME Production Engineering Conference paper (multilithographed; available to March 1, 1962).

The Management Operating System (MOS) is an advance application system relating to the integration and control of forecasting, materials planning, inventory management, scheduling, dispatching, and operations evaluation. The function of each of these is discussed.

It is an advanced application system developed as a result of requests from customers of the authors' company for major answers to their planning and control problems.

MOS is designed for better and more sophisticated production control systems by answering such questions as: "What is the complete cost of stock outs, schedule delays, and bottlenecks?" In terms of dollar value what do they mean in his plant? What is the cost of a report that comes too late to correct an undesirable situation?

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Fuels

Development of a Combination Liquid and Gas Fuel Burner System for Thermoelectric Generators..61—SA-56... By Larry Selwitz, Westinghouse Electric Corporation, Pittsburgh, Pa. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

Burners for thermoelectric generators have been developed to use either liquid or gaseous fuels. Some of the problems involved are unique, for conditions of high heat flux density, isothermal combustion-chamber temperature distribution, high burner efficiency, light weight, and silence of operation must all be optimized to match the over-all thermoelectric-generator requirements.

Heat Transfer in an Infinite Tube-Supporting Surface Combustion..61—SA-59... By D. Gidaspow and R. T. Ellington, Institute of Gas Technology, Chicago, Ill. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

Most efforts to describe surface combustion have been qualitative in nature; the quantitative efforts have frequently involved gross assumption regarding system behavior without proper justification. In this paper a set of equations for one-dimensional change is solved for a constant-pressure process to describe surface combustion in an infinite tube. The reaction rate constant is approximated by a step function of surface temperature. Experimental results are presented to show the validity of the assumption. Experimental reaction rate data for isothermal surface combustion of hydrogen in air in turbulent flow were obtained for a platinum-coated vitreous alumina tube between 200 and 1600 F. The rate of reaction was found as a function of hydrogen concentration and surface temperature. Heat-transfer coefficients with surface combustion were compared with measured coefficient for pure air and agreed closely for the case considered.

The Use of Natural Gas In Open Hearths..61—SA-49... By E. R. Gardner, Assoc. Mem. ASME, The Ohio Valley Gas Company, Steubenville, Ohio. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

During the past few years, the American steel companies have concentrated upon modernization of their facilities, particularly the raw materials through ingot phase of steel producing, including the open-hearth departments. With 50 per cent or more of the cost of finished steel products developing in this phase, further efforts to decrease costs are expected to be accomplished by modernizing facilities and retiring obsolete equipment. Many of these developments have involved new fuel applications to existing steel producing equipment. Some recent applications of natural gas in the open-hearth operation of steel producing are described.

The open-hearth process is continually being improved with new methods of fueling, oxygen application, material handling, refractories, and instrumented control. Some of these aspects are discussed.

Flame Stabilization in a Boundary Layer Over a Cooled Surface..61—SA-53... By R. J. Heinsohn and J. E. Lay, Assoc. Mem. ASME, Michigan State University, East Lansing, Mich. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

It is shown through experiment and analysis that a flame can be stabilized in the boundary layer over a cooled surface. Stabilization is found to depend on the existence of an "anchor point." The experiments show that at a constant free-stream velocity the stabilized flame assumes positions closer to the leading edge as lean fuel-air ratios approach stoichometric proportions. Predictions of the flame position by consideration of purely laminar flame speeds, laminar quenching distances, and the measured boundary-layer velocity profiles disagree with observation. Quantitative confirmation, however, can be attained by replacing laminar parameters with flame speeds and quenching distances which are appropriate to measured turbulence in the boundary layer.

Application of Burner Safety Supervise Controls to Existing Gas-Fired Central Station Boilers..61—SA-54... By Cecil J. Henne, City Public Service Board, San Antonio, Texas. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

Modern day boiler design requires that provision be made for safe, proper operation during the critical, as well as the normal, operating periods. Application of burner supervise controls provides methods of meeting these operating requirements. While operating conditions, and unit characteristics, dictate the extent of control to be provided, an individualized, supervising control system is desirable. Five years of successful burner control operation bear out the fact that reliable burner supervisory controls are available, and capable of providing unit protection.

Reasons for applying burner controls as well as basic requirements and features of a satisfactory burner control are outlined. Choice of major control components as determined by experience with components on similar unit installations is also discussed.

Hydraulics

Cavitation Tests on Hydrofoils Designed for Accelerating Flow Cascade, Report I.. 61—Hyd-1... By F. Numachi, Mem. ASME, Tohoku University, Institute of High Speed Mechanics, Sendai, Japan. 1961 ASME-EIC Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to March 1, 1962).

In the search for a profile outline particularly adapted to incorporation in accelerating cascades, four forms of cascade profiles were designed on the basis of the method devised by the author, and cavitation performance was determined by experiment. In the design, account was taken of experience gained in the past on such work.

The tests resulted in profiles based on the type 3 pressure configuration issuing with the best performance with regard to (*a*) late inception of cavitation in zone III (the case of low performance), and (*b*) low drag at the designed lift coefficient.

Though it may yet be premature to judge that the foregoing evidence already disproves the previous assumption that type 1 profiles should be the best adapted to accelerating cascade (based on the fact that the type 3 proved best for decelerating profiles), the author believes that the foregoing report should provide some guidance in the search for cascade profiles yielding superior performance. It was proved, however, that the present cascade profiles offer performance superior to already established profiles. In this respect, it may be said that the aim of this research was partly accomplished.

Surges in Air Vents Adjacent to Emergency Gates..61—Hyd-2... By I. W. McCaig and F. H. Jonker, H. G. Acres and Company, Ltd., Niagara Falls, Canada. 1961 ASME-EIC Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to March 1, 1962).

Air vents are installed on hydraulic conduits to relieve negative pressures which may occur in the conduit during transient conditions. To determine air vent requirements in gravity flow hydraulic conduits, two conditions must be examined:

1 A sudden increase in conduit discharge.

2 Intake gate closure against a steady discharge.

The first condition may induce negative pressures at high points along the line of the conduit; the second will also induce negative pressures immediately downstream of the intake gate.

This paper examines in detail the drawdown in an intake gate air vent following gate closure against a constant discharge, and derives an expression for the subsequent backsurge. A backsurge is likely to occur in installations where the magnitude of pressure fluctuations at the downstream end of the conduit are relieved by a surge tank.

Complete Pump Characteristics and the Effects of Specific Speeds on Hydraulic Transients..61—Hyd-3... By Benjamin Donsky, Bureau of Reclamation, U. S. Department of Interior, Denver, Colo. 1961 ASME-EIC Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to March 1, 1962).

Complete operating characteristics of pumps with various specific speeds are not readily available. In general, the pump manufacturer supplies the head, brake horsepower, and the efficiency plotted against the discharge for the normal speed of pump operation. From these data one can determine the characteristics of normal pump operation. It is necessary to have the complete characteristics of a pump to determine the operation for all possible steady-state conditions, or to determine transient conditions for normal or abnormal operations. The complete characteristics of a pump consist of the zones of pump operation, turbine operation, and energy dissipation.

Presented are the complete pump characteristics of specific speeds 1800, 7600, and 13,500 (gpm units) in the $v - h_p$ (flow ratio-head ratio) co-ordinate system. The method of developing these three pump characteristics from test data is described. The three are compared, and the effects of specific speed on hydraulic transients caused by power failure or pump shutoff is presented.

A Preliminary Study of Turbulence Characteristics of Flow Along a Corner.. 61—Hyd-4... By F. B. Gessner, Student Mem. ASME, and J. B. Jones, Mem. ASME, Purdue University, Lafayette, Ind. 1961 ASME-EIC Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to March 1, 1962).

In the turbulent flow of a fluid along a corner, secondary flows occur which have a marked influence on the velocity distributions in planes normal to the mean flow direction. All published explanations of the cause of these secondary flows deal with the turbulent structure of the flow. In this paper, measurements of isotach patterns and directional turbulence intensities in the corner of a rectangular channel with zero pressure gradient and a range of free-stream turbulence intensity of 0.8 to 2.3 per cent are reported. (An isotach is a constant velocity line in a plane normal to the mean flow direction.)

Within the range of variables inves-

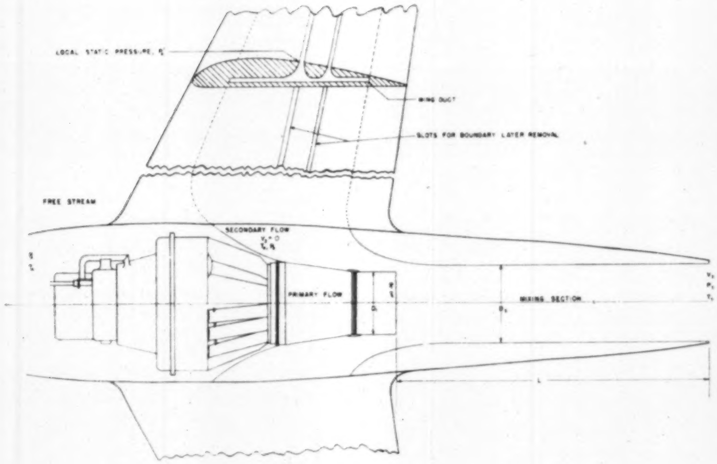


Diagram of ejector application to turbojet aircraft for boundary-layer air removal (61—Hyd-13)

tigated, the following conclusions are drawn: (*a*) Isotach patterns are essentially independent of free-stream turbulence intensity; (*b*) at any point the ratio of turbulence components in orthogonal directions in a plane normal to the mean flow direction is a maximum for directions tangent and normal to the isotach at that point; (*c*) the ratio w'/v', where w' and v' are turbulence components, respectively, tangent and normal to the isotach at any point, is always greater than unity; and (*d*) in the vicinity of the bisector of the corner angle the ratio w'/v' increases with increasing isotach curvature.

A Flow Model for Two-Phase Slug Flow in Horizontal Tubes..61—Hyd-12... By E. S. Kordyban, Linde Company, Division of Union Carbide Corporation, Tonawanda, N. Y. 1961 ASME-EIC Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to March 1, 1962).

A study is made of the behavior of saturated mixtures of water and steam at very low qualities and the results compared with the available correlations. The range of the experimental data covers adiabatic flows at moderate velocities and qualities below 2 per cent at atmospheric pressure in smooth horizontal tubes. The use of glass tubes allow visual observation of flow; the flow pattern is found to be almost entirely in the slug flow region. Based on this, a flow model is developed and the resulting equation resembles rather closely the applicable portion of the empirical Chenoweth-Martin correlation. While the relationships developed here do not compete with the foregoing correlation either in improved accuracy or range, they do, it is felt, offer a logical explanation for its applicability to the slug flow region.

An Experimental Investigation of the Use of Supersonic Driving Jets for Ejector Pumps..61—Hyd-13... By R. V. Deleo and R. E. Rose, University of Minnesota, Rosemount Aeronautical Laboratories, Minneapolis, Minn.; and R. S. Dart, Mem. ASME, U. S. Army Corps of Engineers, Bonneville Hydraulic Laboratory, Bonneville, Ore. 1961 ASME-EIC Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Engng. for Power**; available to March 1, 1962).

The problem of controlling the boundary layer formed on the surface of the wing of an airplane is of increasing importance as the flight speed requirements of present day aircraft increase. At high speeds, the drag caused by separation of the flow behind local shock waves creates a serious loss in performance. In low speed flight, premature separation of the flow occurs at high angles of attack, limiting the maximum coefficient of lift in addition to causing a large increase in the drag.

The main purpose of this study was to establish pumping and thrust performance comparisons between ejector configurations utilizing sonic and supersonic parallel flow nozzles. The application of interest in this particular investigation was in boundary-layer control for turbojet aircraft.

In order to optimize the performance, it was necessary to vary systematically the geometric parameters of mixing tube length to diameter ratio. The primary or driving jet pressure was an important independent parameter and was variable up to 32.0 times the ambient pressure. An ejector-vacuum chamber installation was fabricated and designed in order that the desired parameter ranges might be obtained. Both the ejector and thrust table were mounted inside the vacuum chamber.

Results of the investigation indicated substantial improvement in the pumping and thrust performance of the ejector with supersonic primary nozzles as compared to the sonic jet. A mixing tube length of ten mixing tube diameters was found to give the most satisfactory overall pumping performance. Comparisons between experimental results and theory for the supersonic primary nozzle are included. Experimental investigations were also conducted using a sonic primary nozzle containing a center body at primary temperatures up to 1000 deg F.

Friction Drag on Bladed Disks in Housings..61—Hyd-5... By Robert W. Mann, Mem. ASME, and Charles H. Marston, Assoc. Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1961 ASME-EIC Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to March 1, 1962).

Extra losses from partial admission operation of a gas turbine occur both in the nozzle flow arc and away from it. The latter have been related to the theory of fluid flow over a rotating disk expressing a dimensionless moment coefficient as a function of Reynolds number.

By direct measurements of drag torque, the moment coefficient has been determined over a range of Reynolds number from 2.0×10^4 to 4.5×10^6 for several aspect ratios, axial and radial shroud clearances, and solidities. Losses increase with increasing aspect ratio. Small increases from minimum practical clearance have little effect, but blade pumping losses become severe at radial and axial clearances of the order of half the disk radius. Typical changes in solidity have only small effects on losses.

On the Mechanism of Cavitation Damage by Nonhemispherical Cavities Collapsing in Contact With a Solid Boundary..61—Hyd-8... By Charl F. Naude and Albert T. Ellis, California Institute of Technology, Pasadena, Calif. 1961 ASME-EIC Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to March 1, 1962).

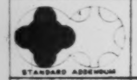
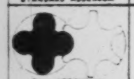
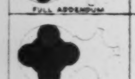
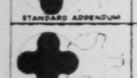
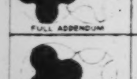
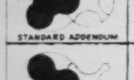
A perfect fluid theory that neglects the effect of gravity, and assumes that the pressure inside a cavitation bubble remains constant during the collapse process is given for the case of a nonhemispherical, but axially symmetric, cavity that collapses in contact with a solid boundary. The theory suggests the possibility that such a cavity may deform to the extent that its wall strikes the solid boundary before minimum cavity volume is reached. High-speed motion pictures of cavities generated by spark methods are used to test the theory experimentally.

Agreement between theory and experiment is good for the range of experimental cavities considered, and the phenomenon of the cavity wall striking the solid boundary does occur. Studies of damage by cavities of this type on soft aluminum samples reveals that pressures caused by the cavity wall striking the boundary are higher than those resulting from a compression of gases inside the cavity and are responsible for the damage.

Characteristics of Helical, Rotary, Positive Displacement Compressors..61—Hyd-18... By Karl E. Wichert, Fairchild Engine and Airplane Corporation, Bayshore, L. I., N. Y. 1961 ASME-EIC Hydraulic Conference paper (multilithographed; available to March 1, 1962).

In surveying the different types of compressors covering a wide range of pressures and flows, it becomes obvious that there is a gap between the range covered by reciprocating machines and that covered by aerodynamic machines. The helical, rotary, positive-displacement machine fills this gap satisfactorily, with a wide margin of overlap at each end of the range, in flow as well as in pressure ratio.

Units of this type, useful as both compressors and expanders, were invented by Lysholm, and later improved by Svenska Rotor Maskiner (SRM). This paper deals with the latter version, which the author's company has named Heli-Rotor.

MALE ROTORS	FEMALE ROTORS	MAXIMUM BUILT-IN VOLUME RATIO Σ max	MAXIMUM WRAP ANGLE φ max	GEOMETRIC CO-EFFICIENT $\frac{A_c}{D^2} = C$	DIAMETER RATIO MALE / FEMALE	SPEED RATIO MALE / FEMALE
 STANDARD ADDENDUM		3.38	300°	.462	1/1	3/2
 FULL ADDENDUM		3.38	300°	.568	1/1.10	3/2
 STANDARD ADDENDUM		3.00	295°	.462	1/.82	5/4
 FULL ADDENDUM		3.00	295°	.604	1/1	5/4
 STANDARD ADDENDUM		2.60	290°	.524	1/.81	4/3
 FULL ADDENDUM		2.60	290°	.602	1/.88	4/3

Typical rotor combinations for positive displacement compressors (61—Hyd-18)

It is intended to apply to the helical, rotary, positive-displacement compressor the techniques learned through long experience with turbo and reciprocating machines. Formulas and equations established in the fields of thermo and gas dynamics are used to calculate and predict the performance and behavior characteristics of this machine. This is an improvement on the longer method described previously.

Generalized Multistage Axial Compressor Characteristics..61—Hyd-14... By G. L. Mellor and T. Root (Dec.), Princeton University, Princeton, N. J. 1961 ASME-EIC Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.;** available to March 1, 1962).

A method is presented of calculating the off-design performance of multistage axial compressor characteristics that differs in concept from previous methods. A set of resulting calculations has certain general properties; namely, that it is independent of absolute stage work and flow coefficient, number of stages, and annulus geometry. The set depends only on a stage characteristic "shape," which is normalized so that the work and pressure coefficient is unity when the flow coefficient is unity. One set of tabulated results can be applied to many different designs. Two comparisons with experiment are present and the agreement is fairly good.

An added benefit derived from this kind of general approach is that one gains physical understanding of the various regions of compressor operation. In this regard the concepts of "axial equilibrium" and "match point" are developed and defined in a precise, quantitative manner.

An Experimental Study of Vortex Chamber Flow..61—Hyd-11... By J. P. Holman, Assoc. Mem. ASME, Southern Methodist University, Dallas, Texas; and Capt. G. D. Moore, U. S. Air Force, Carswell Air Force Base, Texas. 1961 ASME-EIC Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.;** available to March 1, 1962).

It is shown that a relatively simple analysis predicts the functional variation of temperature and pressure in a vortex chamber with radius and inlet velocity. The vortex chamber was constructed of plexiglas with provisions for detailed pressure measurements in the flow. The diameter of the chamber was five inches and the length was four inches, with the flow discharging into either a three-quarter inch or a two-inch tube. The apparatus is similar to a Ranque-Hilsch tube except that all of the flow passes out one end and no attempt is made to separate the cool gas in the center from the hotter stream at the outer periphery.

The predicted variation is in good agreement with experimental observations. By assuming that the flow at the outside of the chamber occupies some effective flow area, which is essentially independent of flow rate, the inlet velocity may be expressed in terms of the chamber dimensions and the fluid properties at entrance. The effective flow area assumption is verified experimentally for two chamber exit configurations using air.

Hydroelastic Vibrations of Flat Plates Related to Trailing Edge Geometry..61—Hyd-16... By G. H. Toebes, Purdue University, West Lafayette, Ind.; and P. S. Eagleson, Massachusetts Institute of Technology, Cambridge, Mass. 1961 ASME-EIC Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.;** available to March 1, 1962).

Vortex-induced vibrations of thin flat plates are studied as a function of trailing edge geometry. In an effort to extend the analysis to a more comprehensive treatment than that provided by the common vortex model, the vibrations are considered as hydroelastic phenomena.

An equation of motion is formulated. From a qualitative analysis of this nonlinear equation some expected features of its solution are set forth. A detailed experimental determination is made of the amplitude spectra of various thin plates mounted at zero mean angle of incidence in the test section of a water tunnel and suspended by a torsion spring through their leading edge. The effects of trailing edge geometry and elastic properties of plate support are explored.

Data analysis gives interesting confirmation of the formulated equation of motion. The vibration is shown to become self-excited and the degree of two dimensionality of the wake is deduced to be determinative in regard to the severity of the vibration.

Problems of Predicting Cavitation Erosion From Accelerated Tests..61—Hyd-19... By J. M. Hobbs, National Engineering Laboratory, East Kilbridge, Glasgow, Scotland. 1961 ASME-EIC Hydraulic Conference paper (multilithographed; available to March 1, 1962).

More reliable methods of predicting possible cavitation damage to hydraulic turbomachinery are required. By using recently developed experimental techniques, the relative rates of erosion in full-scale machines under varying operating conditions have been measured. No absolute determination of damage rate has been possible, however. There is evidence of quantitative agreement between individual laboratory-accelerated cavitation-erosion tests and between such tests and field observations. It is conceivable that operational conditions similar to those prevailing in full-scale machines may be reproducible in accelerated laboratory tests or that the use of models may eventually provide a solution to this problem.

ASME TRANSACTIONS

Journal of Heat Transfer

The August, 1961, issue of the Transactions of the ASME—*Journal of Heat Transfer* (available at $1.50 per copy to ASME Members, $3 to nonmembers) contains the following:

Pool Boiling in an Accelerating System, by Herman Merte, Jr., and J. A. Clark. (60—HT-22)

An Experimental Study of Boiling in Reduced and Zero Gravity Fields, by C. M. Usiskin and R. Siegel. (60—HT-10)

Measured Variations in Local Surface Temperatures in Pool Boiling of Water, by S. T. Hsu and F. W. Schmidt. (60—HT-32)

Natural-Circulation Tests With Water at 800 to 2000 Psia Under Nonboiling, Local Boiling, and Bulk Boiling Conditions, by O. J. Mendler, A. S. Rathbun, N. E. Van Huff, and A. Weiss. (60—HT-36)

Heat Transfer to Laminar Flow Across a Flat Plate With a Nonsteady Surface Temperature, by R.D. Cess. (60—HT-7)

Film Cooling With Multiple Slots and Louvers, by J. H. Chin, S. C. Skirvin, L. E. Hayes, and F. Burggraf. (60—HT-35)

Velocity Distributions, Temperature Distributions, Effectiveness and Heat Transfer for Air Injected Through a Tangential Slot Into a Turbulent Boundary Layer, by J. P. Hartnett, R. C. Birkebak, and E. R. G. Eckert. (60—HT-31)

Two-Phase Slug Flow, by Peter Griffith and G. B. Wallis. (60—HT-28)

Dynamic Response of Heat Exchangers Having Internal Heat Sources—Part IV, by W. J. Yang, J. A. Clark, and V. S. Arpaci. (60—WA-127)

A Comprehensive Approach to the Analysis of Cooling Tower Performance, by Donald R. Baker and Howard A. Shryock. (60—WA-85)

Film-Boiling Heat Transfer From a Horizontal Surface by P. J. Berenson. (60—WA-147)

An Integral Treatment of Two-Phase Boundary Layer in Film Condensation, by J. C. Y. Koh. (60—WA-253)

Oscillations in Two-Phase Flow Systems, by G. B. Wallis and J. H. Heasley. (60—WA-209)

Film Boiling in a Forced-Convection Boundary-Layer Flow, by R. D. Cess and E. M. Sparrow. (60—WA-148)

TECHNICAL BRIEFS

Subcooled Forced-Convection Film Boiling on a Flat Plate, by R. D. Cess and E. M. Sparrow.

Flow Visualization and Velocity Measurement in Natural Convection With the Tellurium Dye Method, by R. Eichhorn.

Truncation Error Estimates for Numerical and Analog Solutions of the Heat-Conduction Equation, by N. H. Freed and C. J. Rallis.

Frictional Pressure Drop in Noncircular Ducts, by R. I. Hodge.

A Musical Heat Exchanger, by Robert Lemlich.

Transition on a Heated Horizontal Rotating Cylinder, by P. D. Richardson.

Free Convection With Blowing or Suction, by E. M. Sparrow and R. D. Cess.

On Jenkins Model of Eddy Diffusivities for Momentum and Heat, by C. L. Tien.

Journal of Engineering for Industry

The August, 1961, issue of the Transactions of the ASME—*Journal of Engineering for Industry* (available at $1.50 per copy to ASME Members, $3 to nonmembers) contains:

Ten Years' Progress in Management, 1950–1960

Foreword, by W. L. Cisler

Management's Past—A Guide to Its Future, by L. M. Gilbreth and W. J. Jaffe. Paper No. (60—WA-67)

The Philosophy of Management, by L. Urwick. (60—WA-55)

Philosophy of Management, by A. M. Lederer. (60—WA-56)

Management as a Profession, by H. F. Smiddy. (60—WA-61)

Practices in General Management:

New Directions for Organizational Practice, by B. J. Muller-Thym. (60—WA-59)

Financial, by R. B. Curry. (60—WA-66)

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International Progress in Management, by E. Mittelsten Scheid. (60—WA-68)

Management Education:

Professional Societies, by C. E. Davies. (60—WA-109)

Industrial, by F. F. Bradshaw. (60—WA-107)

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Fifty Years of Management—A Look Back and a Look Forward, by P. F. Drucker. (60—WA-46)

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COMMENTS ON PAPERS

The Teaching Machine

Comment by Robert E. Fulton[1]

THE Department of Civil Engineering at the University of Illinois is currently conducting a series of Ford Foundation sponsored seminars for its young engineering staff in order to provide for more effective teaching. A recent seminar was devoted to the use of teaching machines particularly as applied to engineering education. A number of opinions were voiced by the writer and others of this group which are appropriate to this article[2] on teaching machines. Some of the comments were as follow:

1 A teaching machine can teach rote learning effectively. There is little doubt from research and experience that a teaching machine can accomplish this and do it effectively. As long as rules are to be taught the machine is at its zenith. Unfortunately, however, in engineering there are only a few places where the student must simply learn the "rules of the game." This does occur within courses but in most cases the fundamental language and rules are sandwiched in with other more important concepts which the student must grasp. These concepts in turn allow the student to see reasons for the "rules." While teaching machines may be appropriate for spelling, languages, and arithmetic it is doubtful if they can fulfill any of the major needs of engineering.

2 The machine cannot teach creativity. The one most important item which an engineering student must learn is to be creative. Creativity is difficult enough to define and also difficult to recognize within a student once he has it. It is questionable even yet whether students are taught this creativity or whether the atmosphere of the classroom and the contact with the teacher merely bring this quality to the surface. Since a machine can only do things that can be defined a priori by the programmer, it will fall down in teaching a concept such as creativity which is not yet firmly established.

3 The machine cannot learn from the student. Anyone who has taught is aware that one of the major sources of teaching improvement for the instructor is the student. In the feedback from the student to the teacher the teacher is able to re-evaluate the material and the manner in which it is being learned and then modify the presentation for the next class. By this never ending cycle the teacher is learning the material better and is in turn teaching more effectively. A teaching machine can only change its teaching techniques in a limited set of prescribed ways which have been included in the machine program. It is difficult to conceive of a machine becoming more informed on a subject the longer it teaches and then utilizing this information for more effective teaching.

4 Machines do have a place in engineering education. It is quite doubtful if teaching machines as discussed by the author will ever be prominent in engineering education; however, the use of machines in another perspective is a fertile field. This is in the area of problem solving by automatic computers. The concept posed here is not to require students to solve intricate engineering problems on a digital or analog computer. Rather it is to have them set up for computer solution problems which could in fact possibly be done by hand computation. Actual programs need not be written in each case; however, some work must be carried through to completion in order to give the student a full appreciation of the task.

Anyone who has ever worked with a computer has become strikingly aware that it was only when he sat down to write a program for the solution to a problem that he began to look at the whole problem in its entirety. One cannot solve a problem on an automatic computer merely groping along a path hoping to find the next road sign. He must map the route from start to finish and separate the difficult parts for special attention. Any departure from this principle yields a reprimand from the machine far more punishing and entailing more extra work than any which an instructor can give. Such an approach requires a deep understanding of the whole problem at hand and piercing foresight through the entire solution. If engineering students can develop this approach to problem solving, they will indeed make a significant step forward. It is in developing this capacity in the student that machines offer the most fruitful avenue of approach for future applications in engineering education.

Author's Closure

The intent of my article[2] was twofold: first, to explain briefly the principles and operation of teaching machines; and second, to urge an objective approach in evaluating the teaching machine.

As an engineer, I feel a justifiable respect, and even admiration, for the achievements of automation. Its long string of successes has tended to build up within me the persuasion that the machine—any machine—is *ipso facto* synonymous with "betterness."

As a teacher, on the other hand, I deal in human values and am disquieted by the relentless sweep of robotry. Automation has societal implications also, and its uncontrolled spread results in dehumanization of the individual. And I feel resentful.

There are thus within me these two antipodal attitudes: One pro and one con. As a consequence I am led to the belief that the proper approach is neither unbridled enthusiasm nor intransigent rejection—but a moderate course charted between the two extremes. However, the teaching machine continues to be the subject of much controversy with technologists and educators flailing away at one another; with the issue far from resolved. In this respect, Professor Fulton's remarks are welcome because full interchange of experiences, test results, and opinions is essential if we are to progress from hypothesis to principle to fact in this area. But I feel that some of the conclusions reached by the seminars of which he writes do the teaching machine an injustice.

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[1] Assistant professor in civil engineering, Department of Civil Engineering, University of Illinois, Urbana, Ill. Assoc. Mem. ASME.

[2] S. W. Groesberg, "The Teaching Machine," MECHANICAL ENGINEERING, vol. 83, April, 1961, pp. 38–39.

While agreeing that the machine is effective in teaching rote material, they question whether the engineering curriculum embodies a sufficient amount of such material to recommend the use of machines. Certainly, "sufficient" is a relative term, but quite a few possible applications do exist. Within the mechanical engineering curriculum (with which this writer is most familiar) the following examples of rote learning might be suitable for the machine:

1 Definitions and manipulations of vector algebra as applied to vectorial mechanics.

2 A considerable body of the material taught in courses dealing with processes of manufacture.

3 Those portions of the freshman course in graphics relating to lettering, dimensioning, allowances and tolerances, and fasteners.

In addition to teaching prime course work, there are other conceivable uses for the machine in the engineering college. Almost every undergraduate experiences difficulty with a given lesson at some time or other. It might not be a bad idea to equip a special room with a battery of teaching machines and to stock it with a library of programs covering all the courses taught. This study room would be available to the students as they saw fit and would provide an effective aid in leading pupils through their troublesome lessons. Another possible use for the machine involves the problem presented by the heterogeneous backgrounds of entering freshmen. They come to college with such varied degrees of preparedness that it is not easy to bring them all up to a common denominator suitable for commencing classroom work. A machine could fulfill this function rapidly, efficiently, and without needless repetition.

Also I agree with the seminar's observation that teachers need pupils as much as pupils need teachers. (And this is still another compelling reason for retaining the classroom structure.) Teachers do profit from the feedback. But the process is not necessarily a "never ending cycle"; it is rather a "decreasing exponential." For example, an instructor's performance might undergo extensive modifications after the first presentation. But after, say, the fifth repetition the changes would be considerably fewer. And eventually, the presentation would approach an asymptote defining the "perfect" lecture. It is at this point, and not before, that a machine program should be prepared. I hasten to add, however, that perfect is merely a figure of speech. No machine lesson can ever be perfect because it lacks that ineffable spark which only the human presence can generate. It may come close in "efficiency"; but in teaching, this small gap represents an important fragment. It represents the unconventional, the singular, the individualistic mind—the precise fragment we wish so desperately to reach. Hence customary measures of efficiency are not truly applicable in engineering education. One further remark in this connection: We ought not dismiss the possibility that teaching machines may eventually be designed so that they are indeed able to alter their techniques in response to pupil feedback. Such self-organizing systems are currently the subject of intensive study and much progress has been made in the field of adaptive servocontrol mechanisms.

As far as creativity is concerned, Professor Fulton's views coincide with mine. Only a human being can help shape something as amorphous as creativity or concept formation. This is why teachers have occupied an important place in every civilization—and will continue to do so. The advent of the printed book made it possible to learn anything known to man. Still, it did not do away with the tutor. Similarly, the introduction of phonograph records, film-strips, and the like has not made the instructor obsolete; nor will programmed material. The impersonal machine will never take the place of the human presence for a simple reason: The true instructor teaches not only what he knows, but also what he is.

Sanford W. Groesberg.[3]

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[3] Mechanical Engineering Department, Stevens Institute of Technology, Hoboken, N. J. Mem. ASME.

Notes on Books Received in Engineering Societies Library

REVIEWS OF BOOKS

Education of an Engineer

The Schools

By Martin Mayer. Harper and Brothers, New York, N. Y., 1961. Cloth, $5^3/_4 \times 8^1/_2$ in., 446 pp., $4.95.

Patterns of Professional Education

By William J. McGlothin. G. P. Putnam's Sons, New York, N. Y., 1960. Cloth, $5^3/_4 \times 8^1/_2$ in., 288 pp., $6.75.

Excellence: Can we be equal and excellent too?

By John W. Gardner. Harper and Brothers, New York, N. Y., 1961. Cloth, $5^1/_2 \times 8^1/_4$ in., xiv and 171 pp., $3.95.

Reviewed by Glenn R. Fryling[1]

WHY should engineers be interested in education? One of the best answers is provided in the following paragraph from the "Faith of the Engineer" published by the Engineers' Council for Professional Development:

> **"Since the Age of Stone, human progress has been conditioned by the genius of my professional forebears. By them have been rendered usable to mankind Nature's vast resources of material and energy. By them have been vitalized and turned to practical account the principles of science and the revelations of technology. Except for this heritage of accumulated experience, my efforts would be feeble. I dedicate myself to the dissemination of engineering knowledge, and especially to the instruction of younger members of my profession in all its arts and traditions."**

Launching of the first Russian Sputnik late in 1957 also marked the beginning of many frenzied attacks and spirited defenses of the quality and content of American education. Much of the debate has been healthy, especially in terms of arousing latent educational interests of a public that had been more distinguished by its apathy than its genuine interest in its schools and colleges. One tangible evidence is the new status of the gifted child, for so many years an irksome (though intellectually appealing) creature to whom many teachers dealt extra assignments as busy work, but now the individual around whom special advanced educational programs are being developed. Another is the growing prestige of school honor rolls, which in some communities have outstripped the athletic letter as a goal to be sought by students of all ages.

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[1] Editor, *Combustion Engineering*, Box 157, Princeton Junction, N. J. Mem. ASME.

What is needed most now, however, is a sense of perspective, a step backward in detachment in order to look forward with clarity. This sentence from an editorial entitled "The Educated Man" published in *The New York Times* is as true today as it was upon its first appearance on Nov. 12, 1957: "We have to think big in terms of education as education, aiming to improve its quality from elementary grades right through the university."

The three books being reviewed fit this quotation aptly, for "The Schools" covers the period from kindergarten through high school, "Patterns of Professional Education" deals with ten specialized fields taught at the university level, and "Excellence" is concerned with the quality of many areas of American life, raising the question of its subtitle, "Can we be equal and excellent too?"

Martin Mayer is a skillful journalist, two of whose previous books encompassed the activities of New York thoroughfares as symbolically different as Wall Street and Madison Avenue. In "The Schools" Mr. Mayer displays a unique combination of intensive background research in educational theory and firsthand reporting of actual classroom activities in about 150 schools, public and private, in the United States and five European countries. While this alternating technique sometimes interrupts the logical continuity of the book, this disadvantage is more than outweighed by the realism of day-by-day educational activities that permeates the work in the form of revealing vignettes.

There are many things to be learned from this book. The engineer who has been stubbornly critical of progressive education may pick up some factual background to go with his emotional attitude in two chapters under the title "How We Got Where We Are": "Up to Progressivism" and "Down From Progressivism." Much interesting information is included on objective tests: How environment affects IQ ratings, how the pressures are growing for uniform external standards determined by national tests, and some of the long-term effects of overemphasis on examinations.

The longest of the three parts, "That's What We learn in the Schools," finds Mr. Mayer at his reportorial best. The chapters in this section are likely to strike the engineer in either of two ways: As a nostalgic retracing of his own school days or as a sort of bench mark against which he may make some judgment of the education his children are receiving. One of the more impressive attributes of this section is the revelation of the amount of repetition and even regression of subject matter that is taught between kindergarten and the end of high school. The following quotation, as an example, expresses the dubious usefulness of second grade in many school systems:

"The child who has really mastered first-grade material does not have much to learn in second grade. . . . By its nature, second grade in American schools is the time when the less mature or less able children can catch up with the group. . . ."

Mr. Mayer describes mathematics education in the elementary grades as "catastrophically bad" and points out that the content of mathematics in grades five through eight amounts to "an almost miraculous stretching out" of new material that might be learned in one year. At all levels there is need to remove the artificial barriers between branches of mathematics, and especially in the high school, to make substantial improvement in the liaison between teachers of science and mathematics.

Yet as Mr. Mayer treats the intellectual barrenness of the junior high school—"the curriculum as it now exists in most cities is so unrewarding that good teachers find it hateful to teach"—and the resiliency to criticism of the high school—"no other American institution in the last generation has received the lambasting in print that has been absorbed by the high school"—the engineer must recognize that it is the graduates of these institutions who will be the professional practitioners of the future. While "The Schools" is in many respects a disturbing book, its disclosures of contemporary pedagogical theory and practice below the collegiate level should be known to every educated person.

Turning now to "Patterns of Professional Education," the engineer will find himself in more friendly as well as more familiar territory. His guide, William J. McGlothlin, is vice-president of the University of Louisville and has had experience in teaching and service with the Tennessee Valley Authority as chief of the Training and Education Branch. The author makes a comparison of education in ten professional fields: architecture, business administration, engineering, law, medicine, nursing, psychology, social work, teacher education, and veterinary medicine. The reader quickly gets the impression that these professions share many common problems and have much to learn from one another. One interesting point that Mr. McGlothlin makes is that the professions could help the public and themselves by adopting a common terminology in their educational programs.

A striking contrast is found in the treatment of aims of education. Whereas Mr. Mayer dismisses this subject as among the dullest and most fruitless of pursuits and as something that cannot be accomplished in an ideal sense in schools, Mr. McGlothlin entitles his first chapter "The Aims of Professional Education" and incorporates at the beginning of each chapter a quotation from one of the most stimulating books ever written on the subject, "The Aims of Education," by the late Albert North Whitehead. Indeed, Mr. McGlothlin shows that the professional school belongs in the university because of its breadth of aim and its sharing of the following common educational objectives: Social understanding, ethical sensitivity, zest for continued study, and advancement of knowledge through research.

Throughout the book, but particularly in the chapters on curriculum and methods of instruction, the author points out the interrelationship of theory and practice, the fact that all professions have their arts and skills as well as their underlying sciences. The engineer reading this book may encounter familiar passages which reflect his own experience and education, yet discover that the author is really describing what goes on in the education of doctors or social workers. The sequence of teaching in medicine, for example, is indistinguishable from engineering as it runs from basic science to professional science to application. So great are the similarities in many areas of professional education that it strikes this reviewer as almost incredible that professional educators have not sought far more to get beyond their narrow confines and study the practices of other specialized fields.

In a chapter entitled "Instruction in Professional Ethics," Mr. McGlothlin concludes that professional schools have not considered their obligation to professional ethics as strong as their obligation to professional competence. "They are not sure which methods of teaching are effective, or even that professional ethics can be taught in such a way as to affect the behavior of students. . . . Until they do more than they seem to be doing, the practice of professional schools will not be worthy of their objective of ethical conduct for their graduates. The schools alone cannot assure that a profession is ethical in its practice. But they are not fully discharging the responsibility to do their part."

The practice of ethics is an appropriate link joining "The Schools" and "Patterns of Professional Education" to the subject matter which John W. Gardner has woven into an unusual book bearing the title of "Excellence." Among the many gems of thought from the president of the Carnegie Foundation for the Advancement of Teaching is this sentence from a chapter on "The Aims of a Free People": "The best-kept secret in America today is that people would rather work hard for something they believe in than enjoy a pampered idleness."

In every walk of life, at every level of education, excellence is a goal worth striving for. And there are many kinds of excellence apart from intellectual activities, for the simplest tasks may be done slovenly or with that extra effort that takes them beyond the commonplace.

Dr. Gardner raises some questions which the thoughtful engineer might try to answer: Is our society "honoring the excellences which are the most fruitful for its own continued vitality? To what excellences is it relatively insensitive; and what does this imply for the tone and texture of its life? Is it squandering approbation on kinds of high performance which have nothing to contribute to its creativity as a society?"

The first part of this book examines the effects and the interactions of three competing principles: Hereditary privilege, equalitarianism, and competitive performance. These might be expressed in terms of an engineering organization: The executive whose position is primarily a result of family ties, the practice of making technical decisions through committees rather than by individuals, and the dog-eat-dog fight for corporate position. All of these are familiar situations, but they are indicative of two critical lines of tension in a democratic society. At some points the emphasis is on individual performance, while in others the restraints on individual performance are more evident. Dr. Gardner correctly points out that this tension will never be resolved and never should be resolved, but the implications of the conflict must be understood.

All of this has a bearing upon educational philosophy and teaching from the kindergarten through the professional schools. Striving for excellence is inherently an individual effort but it must be carried out within a social structure that imposes restraints. Perhaps the most challenging aspect of Dr. Gardner's book is the clarity with which he explores such subjects as the right to a college education and qualities of individual motivation.

As one views education in perspective, it is sometimes the earliest impressions that are the longest lasting. The grade-school teacher who insisted upon perfection in simple tasks and set excellence as a goal to be achieved merits more than a second thought today. These qualities have a usefulness and give personal satisfaction far beyond the elementary level. Indeed the essence of all three books is found in this quotation from "Excellence":

"Our society cannot achieve greatness unless individuals at many levels of ability accept the need for high standards of performance and strive to achieve those standards within the limits possible for them. We want the highest conceivable excellence, of course, in the activities crucial to our effectiveness and creativity as a society; but that isn't enough. If the man in the street says, 'Those fellows at the top have to be good, but I'm just a slob and can act like one'—then our days of greatness are behind us. We must foster a conception of excellence which may be applied to every degree of ability and to every socially acceptable activity. A missile may blow up on its launching pad because the designer was incompetent or because the mechanic who adjusted the last valve was incompetent. The same is true of everything else in our society. We need excellent physicists and excellent mechanics. We need excellent cabinet members and excellent first-grade teachers. The tone and fiber of our society depend upon a pervasive and almost universal striving for good performance."

BOOKS RECEIVED IN LIBRARY

Principles of Feedback Control

By Charles H. Wilts. 1960, Addison-Wesley Publishing Company, Inc., Reading, Mass. 271 p., $6^1/_4 \times 9^1/_2$ in., bound. $8.75. A treatment of some of the analytical methods used in the design of feedback systems, requiring a good background in ordinary differential equations and complex variable theory. Described by the author as "not suitable as a reference handbook," it is a study of the principles of feedback control. Feedback systems are considered in the light of response and error functions, stability, compensation techniques, and the concepts of root-locus and the Nyquist criterion. Multiple-loop, closed-loop, and sampled-data control systems are given particular attention. The final chapter examines the use of the describing function in nonlinear analysis.

Report on the Elevated-Temperature Properties of Aluminum and Magnesium Alloys

Published 1960 as ASTM Special Technical Publication No. 291 by the American Society for Testing Materials, Philadelphia, Pa. 308 p., $8^1/_2 \times 11$ in., paper. $7. Contains data compiled by the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals. Summarized are elevated temperature, tensile and creep-rupture properties of current commercially established aluminum and magnesium alloys. Both wrought and cast alloys are covered in various forms including rolled, forged or extended rod, plate, sheet and castings, both sand and permanent molds, and some data on alclad aluminum alloys. Data are given for each alloy in the form of a title sheet, giving its designation, chemical composition, and specifications; while data sheets give a description of the material, the strength values for the mechanical properties, and tables and graphs of physical properties. By spot-check, the top test temperature for which data are given appears to be 1000 F.

Research on the Rolling of Strip; A Symposium of Selected Papers, 1948–1958

Published 1960 by the British Iron and Steel Research Association, London, England. 216 p., $8^1/_2 \times 11$ in., paper. $3. Seventeen papers selected from those published during the years 1948-1958, dealing with the mechanics of strip rolling. Full citation of source of original publication is given in each case. Topics covered include calculation of roll force and torque in cold strip rolling, cold-rolling, and hot rolling; relations between roll force, torque, and tensions in strip rolling; cold rolling with strip tension; surface friction and lubrication in cold strip rolling; continuous gage control in sheet and strip rolling; and effects of screw and speed-setting changes in gage speed and tension in tandem mills.

The Research Revolution

By Leonard S. Silk. 1960, McGraw-Hill Book Company, Inc., New York, N. Y. 244 p., $5^1/_2 \times 8^1/_4$ in., bound. $4.95. In his examination of the growth potential and performance of the American economy, Mr. Silk views industry's growing realization of the importance of regular, systematic investment in scientific research and development as a new element in capitalism's growth process. This is the "research revolution." The author feels that continuous prosperity and healthy growth of the American economy increasingly depend on such investment, and illustrates how the "revolution" has worked in a major industry in the electronics field. An economist writing for wide distribution, he has condensed his material and avoided specialized terminology to the extent that the book may seem to some to be only a summary of the extensive information obviously at the author's command.

1301 Review Problems

By Russell C. Brinker and others. 1960, International Textbook Company, Scranton, Pa. 388 p., $6^{1}/_{4} \times 9^{1}/_{4}$ in., bound. No price given. The purpose of this book is to provide an intensive practical review for persons planning to take the PE registration examination and the prerequisite EIT (Engineer-in-Training) exam which follows graduation and generally precedes practical experience. Individual problems selected from actual state registration exams form the basis of the review, and are arranged in two sections, corresponding to the two parts of the EIT exams. The "General" section (chapters 1-11) covers such subjects as mathematics, chemistry, statics, thermodynamics, fluid mechanics, electricity, engineering economy, ethics, and contracts. The "Applied Engineering" section (chapters 12-19) covers aeronautical, chemical, civil, mechanical, electrical, industrial and mining engineering, and surveying. The remainder of the book (chapter 20), contains nine complete typical state examinations. Appendixes give answers, symbols and abbreviations, addresses of State Registration Boards, and reference books.

Rubber Red Book, 13th Edition

Published 1960 by Rubber Age, New York, N. Y. 814 p., $8^{1}/_{4} \times 11^{1}/_{4}$ in., paper. $15. The annual edition of a directory of those rubber manufacturers in the U. S. A. and Canada that actually compound and/or process their own rubber; of suppliers to the industry; and of personnel in the industry. Includes sections on machinery, accessories, laboratory equipment, textiles, scrap and reclaimed rubber, natural and synthetic rubber, plastics, latex, and rubber chemicals, as well as lists of consultants, educational courses in rubber chemistry and technology, trade and technical organizations, technical journals, and a who's who of the rubber industry.

Steel Castings Handbook.
Third Edition

Edited by Charles W. Briggs. 1960, Steel Founders Society of America, Cleveland, Ohio. 670 p., $6 \times 9^{1}/_{4}$ in., bound. No price given. An extensive revision of a handbook intended for the purchaser of steel castings, and the design and materials engineer and student. Its 19 chapters discuss steel castings from the standpoints of advantages in mechanical structures and assemblies, industrial applications, purchasing, design, patterns for casting, tolerances, normal variations in properties, physical values, welding, heat-treatment, machinability, manufacture, and particular types. In this latter category, carbon steel and low-alloy grades, and cast steels for special applications resistant to wear, low and high temperatures, heat, and corrosion are described. The final chapter surveys the past, present, and future of steel castings, and a glossary of foundry terms, and engineering tables complete the volume.

Symposium on Spectroscopic Excitation

Published 1960 as ASTM Special Technical Publication No. 259 by the American Society for Testing Materials, Philadelphia, Pa. 62 p., 6×9 in., paper. $2.50. At the 62nd Annual Meeting of ASTM in Atlantic City, June, 1959, this symposium considered some of the parameters involved in obtaining reproducibility and accuracy in spectroscopy. The three papers included here discuss the matrix effect in excitation, the effects of gaseous atmospheres on excitation, and some properties of excitation sources such as flames and electric discharges, including hydrocarbon flames, plasma jets, and high-frequency, interrupted, continuous, and fluid-controlled arcs.

Technical Writing

By Joseph Racker. 1960, Prentice-Hall, Inc., Englewood Cliffs, N. J. 234 p., $6^{1}/_{4} \times 9^{1}/_{4}$ in., bound. $6.95. A handbook written by an engineer with a long and varied experience in technical writing, this book sets forth rules, formulas, techniques, and ideas in technical writing which will help the engineer select those elements of his material which he wishes to communicate, and to organize and present them in a manner which will reach his readers at the level of their understanding. The author first defines "technical writing," and "writing level," and then gives examples of the five levels he sets up—from the operator's or nontechnical level, to the advanced engineering or scientific level of reader understanding. Then the selection of the appropriate words, and letter and mathematical symbols is discussed, followed by description of illustrations, and the preparation of manuscripts. The book has five glossaries of terms used in writing about such special topics as computers, automation, electricity, electronics, guided missiles, radio and radar navigation, space technology, and transistors.

Theoretical Hydrodynamics

By L. M. Milne-Thomson. Fourth Edition, 1960, The Macmillan Company, New York, N. Y. 660 p., $6^{1}/_{4} \times 9^{1}/_{2}$ in., bound. $11. This fourth edition of a standard college text introduces new material in boundary value problem solution, flow under gravity with a free surface, the surface wave of constant form, and comparison theorems. The introductory chapter is based on inferences from Bernoulli's theorem. Chapter 2 discusses vector properties essential to the main theme, and number three the general properties of fluid motion continuity, dynamical equation, pressure, energy, and vorticity. Chapter 4 discusses the properties of two-dimensional motion excluding the complex variable, which is then introduced in chapter 5. Chapters 6-14 give a detailed account of two-dimensional motion from the unified standpoint of the complex variable. The remaining six chapters cover Stokes' steam function, three-dimensional problems, the general motion of spheres and ellipsoids, vectorial partial differentiation applied to Kirchoff's equations, vortex motion, vector methods with viscous liquids, boundary-layer theory, and flow at subsonic and supersonic speeds.

Theorie der Stabilität
Einer Bewegung

By Wolfgang Hahn and Rolf Reissig. 1959, R. Oldenbourg, Munich, Germany. 402 p., $6^{3}/_{4} \times 9^{1}/_{2}$ in., bound. DM 47.00. This translation from the original Russian reviews the basic Lyapunow theory of stability of motion and also presents extended treatments of several practical applications in the field of nonlinear stability analysis. Although essentially mathematical in treatment, it provides a new and useful tool in dynamics.

Warehouse Operations Planning
and Management

By Andrew J. Briggs. 1960, John Wiley & Sons, New York, N. Y. 303 p., $6 \times 9^{1}/_{2}$ in., bound. $8.50. A step-by-step description of the various stages—planning, organization, management, and operation—in the layout or modernization of warehouse operations. It discusses in detail initial study of the problem, fact gathering and analysis, floor plans and space charts, pallets, pallet racks, and bins, the particular tools and materials-handling equipment suited to the job in mind, storage aids, conveyers, stock-locations systems, and finally operating procedures and practices, and management reports and statistics.

ASTM Standards on Textile
Materials, 31st Edition

Published by the American Society for Testing Materials, Philadelphia, Pa. 946 p., $6^{1}/_{4} \times 9^{1}/_{4}$ in., bound. $9.75. This 1960 edition of the compilation of ASTM Standards on Textile Materials contains 139 standards, of which 24 are new, revised, or have had their status changed. Topics covered include wool textiles, man-made fiber textiles, glass and cotton textiles, bast and leaf fiber textiles and Kraft yarns, tire cord, carpets, hosiery, and nonwoven fabrics. Also included are standards on terms and definitions, conditioning, sampling, qualitative and quantitative analysis, and resistance to insects and microorganisms.

AGARD Aeronautical Multilingual
Dictionary

Edited by G. H. Frenot and A. H. Holloway. 1960, Pergamon Press, New York, N. Y. Various pagings, $7^{1}/_{4} \times 10^{1}/_{4}$ in., bound. $20. Comprising terminology in eight languages—English, French, German, Spanish, Italian, Dutch, Turkish, and Russian—this dictionary has been compiled by the Documentation Committee of AGARD. It is based on the "Glossary of Aeronautical Terms" (British Standard 185), and the translations were made by the countries in which the particular language is spoken, with the exception of the Russian translations, made by the British Ministry of Supply. The definitions are detailed, one or more sentences in length, with multiple meanings given when necessary for the words, phrases, and concepts described. These definitions are arranged in 15 topical sections, each entry numbered in a system coded to the section number, and keyed to one of the eight tabbed, alphabetical indexes given at the end of the volume. The 15 sections are: Aeronautics (general); general motion of aircraft (land, water, air); structures; aerodynamics; aerodynes; rotorcraft; aerostats; power plant; propellors; auxiliary services (hydraulic, pneumatic, electrical); navigation; parachutes; air-traffic and ground services; radiocommunication and radiolocation; meteorology.

Annual Review of Nuclear Science, 1960

Edited by Emilio Segrè and others. 1960, Annual Reviews, Inc., Palo Alto, Calif. 617 p., $6^{1}/_{4} \times 9$ in., bound. $7. This tenth annual review contains 15 monographs, each well-documented, dealing with the following topics: Neutrino interactions; nuclear interactions of heavy ions; cosmic-ray showers, and cosmic-ray experiments during IGY; bubble chambers; optics of high-energy beams; nuclear structure in internal conversion; recoil techniques in nuclear reaction and fission studies; recoil methods for labeling organic compounds; the general formalism, experimental data, and phenomenological analysis of nucleon-nucleon scattering experiments; cellular and vertebrate radiobiology; nuclear methods for subsurface prospecting and the energy levels of light nuclei. Also included are cumulative author and chapter-title indexes for volumes 1-10 of the series.

Current Engineering Events, News, and Comment

E. S. NEWMAN
News Editor

THE ROUNDUP

Engineering Salaries on the Upgrade

From the standpoint of salary, the American professional engineer continues to gain increased recognition for his work.

This is the conclusion drawn from a survey of more than 24,000 engineers, conducted and published by the National Society of Professional Engineers of its members.

Median income for those engineers responding to the survey reached a new high of $10,660-up by 6.6 per cent from a similar survey taken in 1958. Further, this increase is reflected at almost all salary levels. The median income figure represents the point at which half of all those surveyed are making a smaller figure, and half are receiving a greater income.

Ninety per cent of the engineers surveyed received salary or income over $7140 in 1960, an increase of $100 over 1958. Three fourths of those surveyed made in excess of $8580, up from $8250 in the previous survey. The top 25 per cent of those answering earned $13,750 or more, an increase in that category from $13,620 in 1958. Only for the top per cent was the decile level unchanged, remaining at $19,680.

This year's survey included 24,326 respondents, up from 18,713 in 1958. Among the reasons for this were a greater number of engineers-in-training and introductory members. Compared with a broader survey of some 200,000 engineers by the Engineers Joint Council (see Mechanical Engineering, April, 1961, p. 113), NSPE engineers are making more money by approximately eleven per cent.

The NSPE survey, which received answers from over 40 per cent of the Society's members, is one of a series conducted and published every two years. The 6.6 per cent median increase is greater than the five per cent figure between 1956 and 1958 but less than the changes recorded for the two preceding surveys—nine per cent in 1954 and twelve per cent in 1956.

The survey indicated that the New England/Middle Atlantic states offered the most lucrative section of the country for the engineer, particularly for the engineer in the higher grades of his profession. By grade and area, the highest median salaries looked like this: Grade I-too few respondents to compute; Grade II-West, $6810; Grade III-Midwest, $7120; Grade IV-New England/Middle Atlantic, $9130; Grade V-New England/Middle Atlantic, $10,990; Grade VI-New England/Middle Atlantic, $13,500; Grade VII-New England/Middle Atlantic, $16,660; Grade VIII-Midwest, $24,930. Grading is done by the engineer himself on the basis of duties, job title, and responsibilities.

Medians by grade for the total United States were as follows: Grade I-$5570; Grade II-$6230; Grade III-$6890; Grade IV-$8640; Grade V-$10,450; Grade VI-$12,260; Grade VII-$15,520; Grade VIII-$21,930.

For the young engineer as well as the average engineer, the salary picture is likewise improved. In tabulation by year of entry into the profession there is a steady increase in starting salaries from 1952, representing a rise over the eight year period of nearly 25 per cent.

Job Market Up For Engineering Graduates

A decided increase in the postgraduate commitments of engineering graduates of 1961 is apparent, in spite of the recent economic recession, according to a report by the Engineering Manpower Commission of Engineers Joint Council released Aug. 11, 1961.

As of May 19, 84.4 per cent of the engineering graduates, covered by the Manpower Commission's survey, had either secured jobs, decided on postgraduate studies, had been committed to military service, or had other definite plans. By June 15, the engineering graduates "committed" had risen to 91.8 per cent. Those in the liberal arts and physical science groups compared favorably with engineering, although the "graduates committed" group among the business and commerce groups were 11 per cent below engineering.

As of May 19, 1959, 83.6 per cent of engineering graduates were committed and, in 1960, 81.5 per cent were committed to postgraduate careers. Of the total, 14.3 per cent of engineers in 1961 were entering graduate studies to pursue advanced degrees in engineering. This contrasts with 9.8 per cent in 1960.

This survey by the Engineering Manpower Commission was based on the response from 138 of the nation's engineering schools representing 16,344 engineering graduates, or a little less than half of the 1961 graduating class.

Inside ASME

The first appearance of "Inside ASME" (page 106) inaugurates what we hope will prove a useful and stimulating avenue of communication between the Society and its 60,000 members (50,000 practicing members and 10,000 student members). From month to month, we intend to take you behind the scenes, showing you the Society in operation.

Metallic Materials Conference Convenes at Estes Park, Colo.

Nearly 160 engineers and scientists from industry, government agencies, and national laboratories attended a technical conference on Metallic Materials for Conventional and Nuclear Power Plant Applications at the Stanley Hotel, Estes Park, Colo., Aug. 1 to 4, 1961. The conference was sponsored by The International Nickel Company, Inc., New York, N. Y., with the co-operation of the Denver Research Institute, University of Denver.

Designed to be of professional interest to engineers and scientists concerned with metallurgical considerations in the design and construction of conventional and nuclear power plants, the four-day session was under the chairmanship of M. A. Cordovi, Mem. ASME, Supervisor, Power Applications, The International Nickel Company, Inc.

It was emphasized that present and future trends toward more economical power have led to a vigorous search to find new materials to meet the ever increasing demands for higher temperatures and pressures by the power industry.

One such new material, discussed at the session on Power Plant Materials Technology, was developed at the company's Bayonne, N. J., Research Laboratory and is designated IN-102. This alloy has a nickel-chromium base and is matrix-strengthened with several per cent each of columbium, molybdenum, and tungsten. It is designed for longtime service at temperatures of 1200 F. Its rupture strength at that temperature is 2 to $2^1/_2$ times higher than materials currently used in such applications. This alloy has excellent structural stability, retaining high ductility after long exposure to temperature and stress.

Data were also presented on Alloy 713C, an investment cast alloy developed originally for short-time service in jet engine turbine blades. Laboratory tests have indicated it will retain its ductility under longtime service.

Both of the alloys are essentially cobalt-free and may therefore find use in nuclear power applications, particularly in steam-cooled and other high-temperature reactors. While not yet commercially available, IN-102 has been produced in a variety of mill forms and is presently in the field trial stage. Alloy 713C is commercially available through a number of investment casting producers under license from the International Nickel Company.

Further details on these two new materials will be presented in a feature article scheduled for a forthcoming issue of Mechanical Engineering.

Other sessions were devoted to metallurgical considerations in nuclear power plant designs, corrosion problems in central power stations, and welding developments and modern practices for nuclear and conventional power plant equipment.

Organizations represented included: Allegheny Ludlum Steel Corporation; Allis Chalmers Manufacturing Company; Anaconda American Brass Company; Argonne National Laboratory; Armco Steel Corporation; Atomics International; The Babcock & Wilcox Company; Battelle Memorial Institute; Bridgeport Brass Company; Byron Jackson; Carpenter Steel Company; Chase Brass & Copper Company; Combustion Engineering, Inc.; Crosby Valve and Gage Company; Diamond Power Specialty Corporation; E. I. DuPont de Nemours & Company, Inc.; General Dynamics Corporation; General Electric Company; Grinnell Company, Inc.; M. W. Kellogg Company; The Martin Company; Nash Engineering Company; National Bureau of Standards; Oak Ridge National Laboratory; Pacific Tube Company; Phelps Dodge Copper Products Corporation; Revere Copper and Brass Company; Scovill Manufacturing Company; and A. O. Smith Corporation.

W. T. Reid, Mem. ASME, of Battelle Memorial Institute led off the conference with a discussion of electric power sources of the future. Portions of his talk will appear in a future issue of MECHANICAL ENGINEERING.

Marcel A. Cordovi, Mem. ASME, supervisor, power applications, International Nickel Company, starts proceedings. The four-day meeting was under the chairmanship of Mr. Cordovi.

MEETINGS OF OTHER SOCIETIES

• IN THE UNITED STATES

September 11–14

SAE, heavy duty vehicle meeting and production forum, Milwaukee Auditorium, Milwaukee, Wis.

September 11–15

ISA, 16th annual instrument-automation conference and exhibit, Biltmore Hotel and Memorial Sports Arena, Los Angeles, Calif.

September 12

SPE, regional technical conference on plastics for tools, Severin Hotel, Indianapolis, Ind.

September 12–14

Southeastern Maintenance and Engineering Show, sponsored by American Institute of Plant Engineers, Greensboro War Memorial Coliseum, Greensboro, N. C.

September 18–20

Standards Engineers Society, tenth annua, meeting on Standards Equals Cost Reductionl Sherman Hotel, Chicago, Ill.

September 19–21

Fourth International Mechanical Pulping Conference, sponsored by CPPA and TAPPI, Edgewater Beach Hotel, Chicago, Ill.

September 20–21

Joint Industrial Electronics Symposium for 1961, sponsored by IRE, AIEE, and ISA, Bradford Hotel, Boston, Mass.

September 20–22

AEC Welding Forum, annual meeting (classified), arrangements by Southwest Research Institute, Granada Hotel, San Antonio, Texas.

September 20–23

American Ceramic Society, fall meeting of the enamel division, French Lick-Sheraton Hotel, French Lick, Ind.

September 24–27

AIChE, national meeting on the management of wastes at nuclear power stations, Lake Placid, N. Y.

September 25–26

Steel Founders' Society of America, fall meeting, The Homestead, Hot Springs, Va.

September 25–28

Second Industrial Building Exposition and Congress, New York Coliseum, New York, N. Y.

September 25–28

AWS, national fall meeting, co-sponsored by AEC Welding Forum, The Society for Nondestructive Testing, and the Welding Research Council, Hotel Adolphus, Dallas, Texas.

October 2–3

ECPD, 29th annual meeting, Sheraton Seelbach Hotel, Louisville, Ky.

October 2–6

Society of Motion Picture and Television Engineers, 90th convention, on the integration of motion picture and electronic systems, Lake Placid Club, Essex County, N. Y.

October 3–5

Second Symposium on Physics and Nondestructive Testing, sponsored by U. S. AEC and Argonne National Laboratory, Argonne, Ill.

October 3–6

Ninth annual Human Engineering Institute, sponsored by Dunlap and Associates, Inc., Stamford, Conn.

October 5

SPE, regional technical conference on plastics foams, Hotel Lafayette, Buffalo, N. Y.

October 5–8

ASID, 17th annual meeting; October 5 at Ambassador Hotel, Los Angeles, Calif.; October 6–8, St. Catherine Hotel, Santa Catalina Island.

October 9–15

ARS, space flight report to the nation and 16th annual meeting, New York Coliseum, New York, N. Y.

October 10–12

ASA, 12th national conference on standards, Rice Hotel, Houston, Texas.

October 10–12

Fifth Conference on Analytical Chemistry in Nuclear Reactor Technology, sponsored by Oak Ridge National Laboratory, Gatlinburg, Tenn.

October 15–19

International Congress on Vacuum Science and Technology, sponsored by the International Organization for Vacuum Science and Technology, Washington, D. C.

October 16–20

National Safety Congress for 1961, Conrad Hilton Hotel, Chicago, Ill. Sponsoring 16 special subject sessions will be the American Society of Safety Engineers, which will hold its annual meeting on October 16 in the Waldorf Room, Conrad Hilton Hotel.

October 19–20

National Conference on Industrial Hydraulics for 1961, sponsored by Illinois Institute of Technology and Armour Research Foundation, in co-operation with engineering societies and industrial organizations, Sherman Hotel, Chicago, Ill.

• IN EUROPE

September 26–29

International Meeting on Heavy Forging, organized by the Camera di Commercio, Industria e Agricoltura with the co-operation of the Associazione Italiana di Metallurgia, to be held in Terni, Italy.

September, 1961

European Organization for Quality Control, fifth annual meeting, Turin, Italy.

November 13–16

National Maintenance Conference and Exhibition, organized by *Plant and Factory Maintenance*, to be held at The Central Hall, Westminster, London, England.

November 16–25

Hungarian Scientific Society for Mechanical Engineering, International festival of scientific and technical films for mechanical engineering, Budapest, Hungary.

• IN CANADA

October 19–November 7

The Iron and Steel Institute, special meeting in the U. S. and Canada.

• IN JAPAN

November 6–11

Society of Chemical Engineers, Japan, 25th anniversary congress exhibition, Sankei Hall, Tokyo, Japan.

(*For ASME Coming Events, see page 99.*)

Fundamentals, Design, and Service Experience in Fields of Creep and Fracture to Keynote International Conference Discussions

A JOINT International Conference on Creep and Fracture will be held in New York, N. Y., Aug. 25–28, 1963, and in London during October, 1963. The sponsors are The American Society of Mechanical Engineers, The Institution of Mechanical Engineers, and the American Society for Testing Materials.

The conference will be devoted to the mechanical properties of engineering materials at elevated temperatures; the emphasis being on the utilization, by the mechanical engineer, of creep and rupture data on current materials in the design of equipment to be used at elevated temperatures.

The scope of the conference will be as follows:

Fundamentals of Creep and Fracture. Mechanisms—atomic lattice; dislocation; material; metallurgical structure, and so on. Plasticity theory in creep—theoretical and experimental studies in uniaxial or combined stresses. Studies in relaxation, thermal and mechanical cycling, rapid and dynamic creep.

Design for Creep and Fracture. Criteria for design—uniaxial and combined stress, thermal and mechanical cycling, relaxation, and creep behavior of composite materials. Application and interpretation of creep and fracture data—information concerning particular materials, short and long-time tests, and extrapolation of data.

Service Experience of Creep and Fracture. Correlation—service data with laboratory tests and methods of testing. Environmental effects—oxidation, corrosion, ablation, erosion, radiation, and the like.

Offers of Papers. Tentative offers of papers, emanating from the United Kingdom, Africa, Asia, Australasia, and Europe with the exception of Japan and the USSR outlining briefly the scope, should be sent as soon as possible to: The Secretary, The Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1, England. Copies of letters should be sent for information to: Mr. N. L. Mochel, Conference Secretary, Westinghouse Electric Corporation, Steam Division, Lester Branch, P. O., Philadelphia 13, Pa.

Abstracts. Offers of papers must be confirmed by abstracts not exceeding 250 words before June 1, 1962.

Manuscripts. Manuscripts must be received by Dec. 1, 1962, for refereeing by the appropriate organizing committee. A Guide to the Preparation of Papers, giving the requirements laid down by the committee, will be sent to all authors whose abstracts are accepted.

The Proceedings of the conference will be published in the English language, but manuscripts may be submitted in any language.

Presentation of Papers. Preprints of papers will be issued to delegates in advance of the conference, and the reporter system will be used in presenting papers for discussion. Simultaneous interpretation facilities in English, French, and German will be provided at the London meetings.

All inquiries should be addressed to: The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1, England.

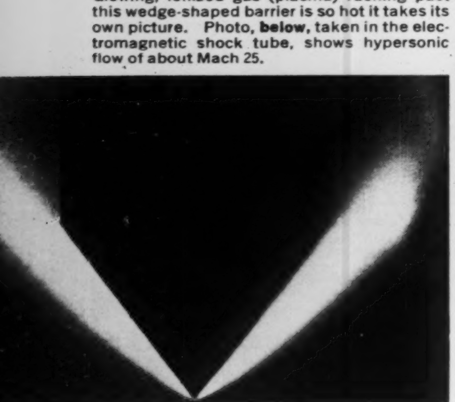
Workshop course on Arc Welding Inspection and Quality Control holds students' attention. This is one of four short courses offered annually by the Hobart Brothers Technical School, Troy Ohio. Course will be offered October 9–13. Other five-day courses are: Welding Fundamentals for Supervisors and Engineers, November 13–17; Automatic Welding for Management, November 27–December 1; and Gas Shielded Arc Welding Processes, December 4–8.

EDUCATION

Gas Dynamics Lab

Northwestern University is expanding its Gas Dynamics Laboratory. Formerly part of the mechanical-engineering department, the Gas Dynamics Laboratory will become an independent interdisciplinary laboratory open to faculty and students from all engineering and science departments. Director of the laboratory is Ali Bulent Cambel, Mem. ASME, professor and chairman of the mechanical-engineering department, who has won international recognition for his research and teaching in gas dynamics. Chief products of the laboratory are research-development engineers (holders of MS and PhD degrees) in the fields of jet and rocket propulsion, plasma and magnetohydrodynamics (mhd).

Glowing, ionized gas (plasma) rushing past this wedge-shaped barrier is so hot it takes its own picture. Photo, **below**, taken in the electromagnetic shock tube, shows hypersonic flow of about Mach 25.



Plasma, termed the "fourth state of matter," along with solid, liquid, and gas, is very hot, electrically charged gas.

Space vehicles intended for interplanetary travel will be propelled by plasma, mhd, or ion engines, say experts. Theoretically, they will permit space travel at thousands of miles per second. Other promising possibilities for plasma include its use to convert cheap, abundant methane into acetylene, and to generate electric power.

Although the laboratory is only seven years old, it has completely transferred its emphasis more than once. Cambel reports that up until three years ago, emphasis was on chemically fueled engines. Now it is on electrical space engines and power generation (both using plasma and mhd schemes).

Ali Bulent Cambel, Mem. ASME, director of the Northwestern University Gas Dynamics Laboratory, adjusts the laboratory's hyperthermal plasma jet, used to examine the properties of plasma, the "fourth state of matter." Plasma in the jet reaches temperatures up to 40,000 F.

The laboratory has been turning out an average of three PhDs and a dozen research papers and books yearly, figures that will rise with the new expansion.

Industry and Education

● Rockwell Manufacturing Company has established a professorship in engineering at the Pennsylvania State University. It is the first corporation to take part in the university's new Great Scholars Program for advancement in graduate teaching and research. Willard F. Rockwell, Jr., Fellow ASME, president of Rockwell, expressed the hope that other corporations would co-operate in the program. Rockwell has pledged a minimum of $125,000 over a five-year period. It is said of the new program that it will enable Penn State to invite eminent scholars to join the faculty on a permanent basis.

● "Cost Reduction Through Materials Handling" is the theme of the ninth annual essay contest sponsored by the Industrial Truck Division of Clark Equipment Company. The 1961 contest, which is conducted by the American Material Handling Society, will have a first prize of $2000 and nine other prizes totaling $3000 for the best papers submitted on the subject. The contest closes April 1, 1962. Details and rules of the contest may be obtained from local chapters of the American Material Handling Society or by writing to: Industrial Truck Division, Clark Equipment Company, Battle Creek, Mich.

United Engineering Center

ASME Over the Top

The response to President Byrne's letter has been tremendous. Thirty-two hundred members have added $50,000 to ASME's subscriptions to the United Engineering Center. Thirty-five sections have exceeded their quota, nine others have less than $500 to go, to meet their quotas. Every Section in the Society marked up some gain during June and July. Notable additions were logged by Iowa-Illinois with an 18.9 point improvement to 102 per cent of quota, and Southern Tier with a 17.8 point improvement to 120.7 per cent of quota. Waterbury continues to forge ahead at 186.3 per cent quota, closely followed by those stalwarts of Region V, Dayton 169.3 per cent, Cincinnati 167.4 per cent, and CAM 157.7 per cent.

Milwaukee is to be commended. The Section management, to achieve quota, subscribed $285 on June 20. This contribution sparked a response that carried the Section upward to 104.5 per cent of quota.

Honor Roll

Per Cent Quota Achieved

Waterbury	186.3
Dayton	169.3
Cincinnati	167.4
C.A.M.	157.7
Worcester	156.8
Youngstown	155.3
N.W. Florida	145.0
Hudson Mohawk	144.3
West Virginia	133.7
Metropolitan	130.1
Atlanta	129.4
Providence	124.0
Fairfield	122.9
Hawaii	121.7
Detroit	121.4
Southern Tier	120.7
Central Iowa	118.4
Birmingham	118.2
Anthracite-Lehigh Valley	116.7
Columbia Basin	115.8
Central Indiana	108.6
St. Louis	108.3
Olean	107.8
Westmoreland	107.4
North Alabama-Mississippi	105.1
Erie	105.1
Milwaukee	104.5
Sabine	104.3
Gulf Coast	104.1
San Diego	104.0
Fort Wayne	103.5
Columbus	103.4
Cleveland	103.1
Inland Empire	102.3
Iowa Illinois	102.0

Member participation 75 per cent and over

N.W. Florida	102.0
Piedmont Carolina	85.9
Columbia Basin	80.3
Mid Hudson	79.6
West Virginia	79.5
Toledo	79.2
Gulf Coast	76.8
Fort Wayne	75.3

Dollars short of quota, top ten sections

New London	$ 40
Mid Hudson	58
Greenville	156
Rock River Valley	204
Kansas City	243
Piedmont Carolina	275
Pittsburgh	312
Nebraska	421
Susquehanna	486
Miami	517

Member participation has been a problem in a number of sections. Special commendation is due the management of eight sections, where, by intelligent persistent campaigning, at least 75 per cent of the local roster has supported the campaign. These sections, headed by N. W. Florida at 102 per cent are listed elsewhere on this page.

Among the larger sections, below quota, special mention should be made of the progress chalked up by Boston and Chicago. Both sections have demonstrated what can be done by an intelligent appraisal of the local problem. Chicago is up to 88 per cent of quota, and has 66 per cent member participation. Boston has topped 81 per cent of quota, and contributions from this area are still coming in.

Help has come from all over the world. Members in India, Thailand, Africa, the Far East, South America, Mexico, and Europe have all responded generously to President Byrne's appeal. The letters received have been an inspiration. Support of ASME is a must, whether a member be in the Damodar Valley in India or in Pretoria, South Africa. To those members, the need for an efficient adequate headquarters is as essential to their professional growth as is the air they breathe to their physical well being.

While it is gratifying to report that ASME has exceeded its quota, there are two hard facts that must be faced: (1) There are over $105,000 in unpaid ASME pledges, most of them due next year; and (2) the over-all membership drive is still $200,000 short of its goal.

Hence it is important that ASME pledges be paid up as soon as possible. And, to insure successful completion of the entire campaign, the Council has decided that the campaign will close at the end of December, 1961. There are a number of Sections anxious to improve their participation in the United Engineering Center. The four months ahead will give them a chance to do so.

Housewarming

By the time you read this, we shall have moved into the new United Engineering Center, having left the venerable Engineering Societies Building which served as headquarters for the great engineering societies for some 50 years. Andrew Carnegie made the old building possible: This time, it was tens of thousands of "Carnegies"—among them, you. Don't fail to visit your new Center when in New York. You can combine your visit with a trip through the United Nations. We front on United Nations Plaza. The famous international building is just across the street.

Upcoming UEC Events

Look for Mechanical Engineering stories on. . .

- **Moving to the Center (October)**
- **Pictorial tour of ASME HQ (November)**
- **Member Gifts Campaign wrap-up and Dedication of the Center (December)**

View of UEC on August 4

Notes on Society Activities and Events

E. S. NEWMAN
News Editor

THE ASME NEWS

American Standard Adds New Dimension to Freight Containers—Interchangeability

FREIGHT containerization for highway, maritime, and rail transportation has taken on a new dimension of interchangeability with the approval of the first American Standard specifying length, height, and width of van containers.

Approved by the American Standards Association, the new standard establishes nominal lengths of 10, 20, 30, and 40-ft for van containers with a cross section of 8 ft × 8 ft. The first in a proposed series of American Standards in the containerization field, the standard was developed by a sectional committee of 75 national organizations and associations. A standard still under development concerns exact sizes of van, cargo, and pallet containers. The objective of this family of standards is to permit complete interchangeability of van containers, expediting handling, transfer, and reshipment.

One of the participating organizations on the committee, the U. S. Maritime Administration, announced recently that all ships designed to carry containers for which construction-differential subsidy or government-insured mortgages are sought must be designed to accommodate standard sizes of containers as specified by the new American Standard.

Standards work in the containerization field began in December, 1957, following a proposal for a study submitted to ASA jointly by the American Material Handling Society and The American Society of Mechanical Engineers. Both organizations now serve as administrative sponsors of the 75-member committee.

Some of the advantages cited by the committee in the application of the standard included the reduction of pilferage, breakage, insurance costs and paper work, provision for weather-tight packaging and the elimination of repackaging in transit.

"American Standard Specifications for Freight Containers (Nominal Van Container Sizes), MH 5.1-1961" establishes a pattern for standards work in the field and is regarded as an essential step in establishing container dimensions. Until standards work was instituted the problem of size was an internal one for each transportation medium; now, all parties concerned have uniform sizes adaptable to highway, maritime, and rail transportation.

The importance of the standard in marine and maritime transportation was stressed in the announcement by the U. S. Maritime Administration.

Thomas E. Stakem, chairman of the Federal Maritime Board and Maritime Administrator, said, "Approval by the American Standards Association of standard sizes for van containers is of great importance to the Merchant Marine. The use of containers by ocean carriers as a means of reducing handling costs and providing shipper service is steadily growing. We expect that the publication of the standard will greatly enhance this growth by removing uncertainty as to future size trends and opening the way to complete interchangeability between rail, highway, and sea transport media."

Noting the aspects of international containerization, Mr. Stakem added, "We must press with all possible speed for international standards which are so necessary for foreign commerce." Application of international standards will tentatively be discussed in September at a meeting of a project committee of the International Organization for Standardization (ISO) in New York.

Copies of American Standard MH5.1-1961 are available from ASME Order Department, United Engineering Center, 345 East 47th Street, New York 17, N. Y.

ASME Elects Eight to Grade of Fellow

ASME has honored eight of its members by electing them to the grade of Fellow.

To qualify a nominee must be an engineer with acknowledged engineering attainment, have 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and be a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or Members of the Society to the Council, to be approved by the Council.

These men were so honored for their outstanding contributions to their profession and to the Society:

Sigmund N. Fiala, vice-president and chief engineer, American Electric Power Service Corporation, New York, N. Y., was elected Fellow ASME. He has had a major role in the development of his company's electric power system which has been expanded from 926,000 kw, in 1934, to 5,558,000 kw. The expected capability, when the current construction program is completed, in 1963, will be 7,789,000 kw.

Robert M. Homan, vice-president and chief engineer, and member of the board of directors, Gilbert Associates, Inc., Reading, Pa., has contributed greatly to the advancement of the art of mechanical engineering in the field of steam-electric-power generation. He was elected to Fellow ASME for his work in the development of reheat thermal cycles in major steam electric generating plants as evidenced by the 37 generating units totaling 4,166,250 kw engineered by his company in the past ten years; the development of the idea of the low-head-type of boiler design; the development of the application of cooling towers to plant sites having limited amounts of cooling water and limitations on heat pollution of circulating water effluent; and his studies which introduced new ideas for the application of equipment to affect desirable economies in the development of new plant sites and installation of major power stations.

Emil T. P. Neubauer, vice-president in charge of engineering, Copeland Refrigeration Corporation, Sidney, Ohio, whose career parallels the history of the commercial air-conditioning industry, was elected Fellow ASME. He has been a pioneer of the high-speed compressor, developing machines for 1160 rpm and 1800 rpm. Machines developed by him have represented the foundation of the air-conditioning business for the York Division of Borg-Warner Corporation, York, Pa., and the Trane Company, La Crosse, Wis. He also is noted for particular advancements in seals and valves in conjunction with the overall achievement of the compressor, and for his work relating to the Manhattan and Oak Ridge projects. He served as secretary-treasurer ASME Susquehanna Section, 1937–1942; and director, Milwaukee Section, 1946–1947.

Daniel Schild, **left**, presents an ASME Fellow Grade Membership Certificate to Emil T. P. Neubauer, vice-president in charge of engineering, Copeland Refrigeration Corporation.

Harry Hewes Sullivan, president, H. H. Sullivan, Inc., Rochester, N. Y., was elected Fellow ASME for his achievements in the field of blueprinting and copying machines. He founded the Paragon Revolute Corporation, manufacturer of high-speed light-copying machines for industry, and later the H. H. Sullivan Company, Inc., a blueprinting and engineering supply business. He went into business in 1908. His goal: To earn $25 a week and build the fastest and best blueprint machine. He subsequently built the two enterprises into a multimillion dollar operation.

Edwin Crankshaw, chief engineer, Cleveland Graphite Bronze Division, Clevite Corporation, Cleveland, Ohio, is an authority on the mechanical design of bearings and the selection of bearing materials. In particular, he is recognized for his development of a bearing material that is considered superior for applications involving high temperatures and repeated high loads, while also having the ability to withstand abrasive particles without damage and to resist corrosion and disintegration from the action of certain oils. He is past-chairman of the ASME Cleveland Section and has served on the Executive Committee of the Oil and Gas Power Division.

LeRoy F. Deming, manager, Power Generation Branch, Navy Department, Bureau of Yards and Docks, Washington, D. C., was recognized for his work on combustion. An authority in the field, he has been granted a patent for a new development in the combustion process. Mr. Deming was responsible for the present Navy policy that for security reasons, wherever practical, essential Navy plants ashore must be equipped for continuous operation on more than one fuel, and that, wherever practical, they must use that fuel involving the lowest total cost to the Government. In the interest of Government economy, he developed the Navy specification for factory fabricated oil and gas-fired water-tube boilers up to 60,000 lb/hr capacity. The specification reduced by about 50 per cent the cost of oil and gas-fired boilers. Mr. Deming was a member of the first mechanical-engineering panel of the Board of Examiners for the rating of applicants to fill civil-service engineering positions in the Navy Department and as a result of his persistence professional registration is today a significant item in the applicant's favor. In 1956–1957 he was chairman of the ASME Washington, D. C., Section, and takes an active part in the affairs of the Fuels Division.

Edward S. Dennison, director, Maritime Gas-Cooled Reactor (MGCR) Project Propulsion Plant, Electric Boat Division, General Dynamics Corporation, Groton, Conn., proposed the development of a nuclear reactor, gas-turbine power system, which later materialized as the MGCR Project. Among other engineering achievements, principally in the field of thermal power processes, he initiated a new controllable-pitch propeller development, devised special refueling equipment for the nuclear submarine *Triton*, and contributed to various mechanical and hydraulic systems devices. He holds more than 14 patents for a variety of devices.

Carroll Foster Hardy, director, Bituminous Coal Institute, National Coal Association, Washington, D. C., is an authority in the technology of coal utilization. He was elected Fellow ASME for his work in creating, directing, and staffing the Bituminous Coal Institute, which has contributed to the expansion of coal markets and the modernization of coal-burning heating and power plants. As a fuel engineer on the Coal Producers Committee for Smoke Abatement during the war, he made pioneer studies in the causes and correction of air pollution. His work has benefited fuel users, community relations, and the national effort to conserve natural resources.

ASME
COMING EVENTS

September 14–15, 1961
ASME-AIEE Engineering Management Conference, Hotel Roosevelt, New York, N. Y.

September 24–27, 1961

ASME-AIEE National Power Conference, St. Francis Hotel, San Francisco, Calif.

September 24–27, 1961

ASME Petroleum Mechanical Engineering Conference, Muehlebach Hotel, Kansas City, Mo.

October 4–6, 1961

ASME Process Industries Conference, Shamrock Hilton Hotel, Houston, Texas

October 5–7, 1961

ASME-AIME Joint Solid Fuels Conference, Dinkler Tutwiler Hotel, Birmingham, Ala.

October 17–18, 1961

ASME Bulk Solid Handling Symposium, Pick Nicollet Hotel, Minneapolis, Minn.

October 17–19, 1961

ASME-ASLE Lubrication Conference, Morrison Hotel, Chicago, Ill.

November 26–December 1, 1961

ASME Winter Annual Meeting, Statler Hilton Hotel, New York, N. Y.

January 24–26, 1962

ASME Second Symposium on Thermophysical Properties, Princeton University, Princeton, N. J.

March 4–8, 1962

ASME Gas Turbine-Process Industries Conference and Products Show, Shamrock Hilton Hotel, Houston, Texas

April 5–6, 1962

ASME-SAM Management Engineering Conference, Statler Hilton Hotel, New York, N. Y.

April 9–13, 1962

ASME Metals Engineering Division—AWS Conference, Sheraton Cleveland Hotel, Cleveland, Ohio

April 10–11, 1962

ASME-AIEE Railroad Conference, King Edward Hotel, Toronto, Canada

April 15–19, 1962

ASME Oil and Gas Power Conference and Exhibit, Shoreham Hotel, Washington D. C.

April 30–May 3, 1962

ASME Design Engineering Conference and concurrent Show, Chicago Exposition Center, Chicago, Ill.

May 7–8, 1962

ASME Maintenance and Plant Engineering Conference, Royal Orleans Hotel, New Orleans, La.

June 4–8, 1962

Nuclear Congress (Biennial), New York Coliseum, New York, N. Y.

June 5–7, 1962

ASME Fuels Symposium, Rutgers University, New Brunswick, N. J.

June 10–14, 1962

ASME Summer Annual Meeting, Chateau Frontenac, Quebec, Canada

(*For Meetings of Other Societies, see page 94.*)

Note: Persons wishing to prepare a paper for presentation at ASME National meetings or Division conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, United Engineering Center, 345 East 47th Street, New York 17, N. Y. Price to nonmembers, 50 cents; to ASME members, free. Also available on request is a "Schedule of Program Planning Dates for Meetings and Publication Deadline Dates." Ask for Form M&P 1315.

Material-Handling Equipment Industry Midyear Review and Outlook for 1961

THE Business and Defense Services Administration General Industrial Equipment and Components Division of the U. S. Department of Commerce recently reported that sales of material-handling equipment are recovering slowly from the low level of the final quarter of 1960. In the first six months of 1961 they will probably be about equal to those in the first half of 1960. However, the industry expects sales during the second half of the year to increase at least ten per cent over the first six months, resulting in a little better yearly total than in 1960.

Trends in Early 1961. The material-handling equipment industry, whose annual production is in excess of a billion dollars, produces a variety of equipment used by most industrial and commercial establishments: Conveyers and conveying equipment; electric overhead traveling cranes; elevators and moving stairways; cranes and hoists; and industrial trucks, tractors, and stackers. It employs 35,000 and pays them annually about $175 million.

The index of bookings for material-handling equipment was 116 in January, 114 in February, 137 in March, 110 in April, and 136 in May (1954 = 100). Data for the index are collected from the members of five associations by the Materials Handling Institute, Inc. The average January-May index of 122 compares with 123 for 1960, 132 for 1959, and 109 for 1958. Many industry sources report increased interest in new equipment during the past two months.

The 1961 Outlook. If the anticipated ten per cent increase in sales in the second half of 1961 eventuates, production for the year should be slightly greater than in 1960.

The projections for 1961 have been made with an assumption that production and shipments will not be affected significantly by any worsening in the cold war situation.

Engineering Students Win Woman's Auxiliary to ASME Awards

Mrs. Crosby Field

MRS. ETHEL HENRIKSEN FIELD, wife of Crosby Field, Fellow ASME, inventor and engineer, died on Aug. 8, 1961, at Lutheran Medical Center, Brooklyn, N. Y.

Mrs. Field who had at one time been President of the Auxiliary to the ASME and had taken such an active part in the Auxiliary's scholarship and loan funds was also former president of the Women's Engineering Club of New York.

A club woman of note she was president of the Cresco Club in Brooklyn and former secretary of the Bay Ridge Reading Club. She had served many times as a delegate to the New York State Federation of Women's Clubs.

She leaves also three daughters, Mrs. Margaret Norbeck, Houston, Texas; Mrs. Dorothy Hole, and Mrs. Patricia Clyne; and six grandchildren.

Sylvia W. Farny Scholarship Fund. Again, this year, two Sylvia W. Farny Scholarships of $500 each, were awarded. One went to Edward Charles Irwin, the other to Harry Everett Ladd.

Mr. Irwin, 22 years old and single, is a student at the University of Washington in Seattle. His average is 3.33. He works during the summer months and is a part-time janitor while attending the University. His references state he sets an excellent example for his fellow students by full participation in social activities, athletics, R.O.T.C. program, and student activities without sacrificing his academic integrity.

Mr. Ladd, 21 and single, attends Ohio State University, Columbus, Ohio. He is third in a class of 17. He works during the summer months and is a part-time student assistant in the Department of Engineering Drawing. He is also a student counselor.

With these two awards, a total of 25 scholarships of $500 each have been

A Recipient Writes

Davis Hall
Grand Forks, N. D.
April 16, 1961

Dear Mrs. Gethen:

The school year is near its end, so I thought you may be interested in the progress of the last few months.

I was fortunate enough to receive an "A" average the first semester. A considerable amount of time has been available for work in the Honors Program, thanks to your Scholarship. My project in this program, the design, construction, and operation of a water table for the Mechanical Engineering Department, is nearing completion. This project also enabled me to obtain membership in Sigma Xi, the research honorary.

A BSME degree will be obtained in June. The Massachusetts Institute of Technology has offered a $3300 fellowship for study in Aeronautical Engineering, and this has been accepted.

I hope to do my best to uphold the confidence shown to me by your group and others. Again, my thanks to your group.

Sincerely,

Kenneth G. Harstad[1]

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[1] Mr. Harstad was one of the recipients of the 1960-1961 Sylvia W. Farny Scholarships.

given by the fund since it was established.

The Sylvia W. Farny Scholarship is awarded annually to an American student in mechanical engineering enrolled in a college or University in the United States, in which there is an ASME Student Section for use in the final year of study.

Serving on the Sylvia W. Farny scholarship Committee are: Mmes. Crosby Field, Clarence Kent, W. H. Larkin, R. W. Worley, and G. S. Gethen, Chairman.

Marjorie Roy Rothermel Memorial Scholarship Fund. Two scholarships were granted in 1961; one to Chesley Ward Angle, and the other to Donald Ray Baker.

Mr. Angle, age 31, received his bachelor's degree in mechanical engineering at the University of Wyoming, Laramie, Wyo., in June. He has maintained an "A" average throughout his college years. At age 14, he began working on a ranch to earn money for an education. In 1951, he enlisted in the Air Force, and after investigation by the F.B I., was stationed at the Limestone, Me., base. Mr. Angle is married and has two children. He has earned scholarships from Carter Oil—three years, and Wyoming Society of Professional Engineers—one year. He received the *Time* Magazine Award in 1958. He is a member of Chi Gamma Iota, secretary of Sigma Tau, honor fraternities, and a member of Joint Engineering Council. The head of the Mechanical Engineering Department wrote: "As Chairman of the Student Section of ASME, Mr. Angle has led a campaign for improved operations and better programs, with greatly increased interest, participation, and membership resulting." Mr. Angle expects to work toward a master's degree in ME at the University of Wyoming.

Mr. Baker, age 31, was graduated from the University of Florida, Gainesville, Fla., in June, with an "A" average in mechanical engineering. He, too, has earned 100 per cent of his expenses, and on two occasions had to withdraw from school in order to build up sufficient reserve to re-enter. Mr. Baker is a member of Iota Pi Sigma and president of Sigma Tau, honor fraternities; a member of the ASME Student Section and of the Student Tutor Society. He has been on the Dean's List four semesters and has honor-student classification. He received an RCA Scholarship-1960–1961, and four tuition scholarships. He worked for three years as air-conditioning designer and estimator; nine months as junior mechanical designer, and one and a half years as structural-steel designer. Mr. Baker expects to work for his master's degree in ME in 1961–1962.

The Marjorie Roy Rothermel Memorial Scholarship is the "newest" of the four Educational Funds maintained and administered by the Woman's Auxiliary to the ASME. It is a $750 scholarship awarded annually to a graduate in mechanical engineering for use in study toward an advanced degree in engineering.

Serving as Committee Members are: Mmes. F. H. Fowler, Jr.; E. R. Kaiser; Allen Latham, Jr.; D. V. Minard; and F. W. Miller, Chairman.

The Calvin W. Rice Memorial Scholarship Fund. The Calvin W. Rice Memorial Scholarship for 1961–1962 has been awarded to Wanchi Pahnichaputt of Thailand. He was chosen from among applications from students of nine foreign countries submitted to the Scholarship Committee for study by the Institute of International Education.

Mr. Pahnichaputt, 25 years old, graduated with honors from Chulalongkorn University at Bangkok, and was recommended highly by his professors at the University and the Selection Committee in Thailand. He has been employed by the Royal Irrigation Department in the Mechanical Division of the Ministry of Agriculture, and wants to specialize in machine design for hydroelectric plants.

Edward C. Irwin

Chesley W. Angle

Harry E. Ladd

Donald R. Baker

The Calvin W. Rice Memorial Scholarship is a grant of $1500 for the maintenance of a foreign mechanical-engineering student during one academic year of graduate study in engineering in the United States.

Through a United States Government grant, Mr. Pahnichaputt will attend an Orientation Course at the University of Arizona from July 12 to September 6 for intensive and extensive English language training, together with general lectures on the United States, its history, literature, and political institutions. This grant also provides tuition and casual fees, $130 for books and supplies during the academic year, and travel costs from the student's home country to the institution at which he will study and return.

Mr. Pahnichaputt has been accepted at Purdue University in the Department of Mechanical Engineering as a graduate student.

The Institute of International Education in New York assists the Department of State in administrating this program. They make all arrangements for the student while he is in this country studying under the scholarship. This is done without any cost to the Auxiliary.

From 1939 to 1945 the Scholarship was granted to students from Argentina, Brazil, Ecuador, and Chile. After the war, awards were made to students from Hungary, Finland, Norway, France, England, Italy, Turkey, Lebanon, Greece, Mexico, Peru, and Thailand.

Scholarship Committee Members are: Mmes. W. H. Byrne, W. E. Karg, J. W. Wilkenfeldt, C. H. Young, and A. R. Cullimore, Chairman.

The Student Loan Fund. To date, the Auxiliary has 92 accounts on the books, representing original grants of $39,570 to students in 42 engineering schools throughout the United States.

Since Jan. 1, 1961, the Auxiliary has granted 35 loans, totaling $13,520. In the calendar year 1960, 39 loans, totaling $17,400 were granted; and during 1959, 33 loans totaling $13,795 were granted.

Under the Student Loan Fund, loans are made to junior, senior, or graduate students of mechanical engineering in good standing, enrolled as a candidate for a degree in a college or university in which there is an ASME Student Section.

The maximum loan is $500 and all loans are interest free while the students are in school. Upon graduation, the interest rate is 2 per cent for one year and 3 per cent thereafter until the loan is repaid in full.

Serving on the Student Loan Fund Committee are: Mmes. C. Bertelsen; H. R. Kessler; E. J. Sharkey, Jr.; J. C. Somers; D. J. McDonald, Jr.; assistant treasurer; and W. F. Friend, Chairman.

Joint Lubrication Conference in Chicago to Discuss Latest Research and Development Studies in the Field

THE eighth annual Joint Lubrication Conference is devoted exclusively to the latest research and development studies in the field of lubrication. Timely topics on advanced problems and solutions dealing with lubrication will be presented during the technical sessions.

The conference is sponsored by the ASME and American Society of Lubrication Engineers Lubrication Divisions. The meeting will be held Oct. 17–19, 1961, at the Morrison Hotel, located in Chicago's Loop area.

Considerable effort went into producing the technical program, and some of the subjects covered by the carefully selected papers include:

Lubrication in vacuum for outer space—bearing experiments, lubricant evaporation, wear and friction studies (followed by open discussion).

Gas Bearings—analysis, designs, applications, and performance of externally pressurized and self-acting configurations.

Rolling-contact bearings—studies at extreme temperatures and speeds; materials, methods of lubrication, endurance life. Instrument bearings.

Properties of lubricants—greases, gases, liquids, solids. Thermal and atmospheric influences.

Chemistry of surface films—interaction of lubricated metal, lubricant and environment and their contribution to lubrication processes. Special research techniques.

Friction and wear—studies to clarify lubrication processes and properties of materials in sliding contact.

Gears, liquid-film bearings, metal processing, nuclear systems, will be discussed also.

▶TUESDAY, OCTOBER 17

Session 1 9:30 a.m.

Aerospace Lubrication

Bearing and Lubricant Requirements for Some Aerospace Projects: Discussion and Preliminary Investigation, by *R. H. Larson* and *A. G. Piken*, Bendix Res. Labs, Southfield, Mich. (ASLE Paper No. 61LC-1)

Solid Lubrication of Metal Surfaces at Very High Sliding Speeds, by *T. D. Witherly*, Stanford Res. Inst., Menlo Park, Calif. (ASME Paper No. 61—Lub-16)

Friction, Wear, and Evaporation Rates of Various Materials in Vacuum to 10^{-7} mm Hg, by *D. H. Buckley, M. Swikert*, and *R. L. Johnson*, NASA, Lewis Research Center, Cleveland, Ohio (ASLE Paper No. 61LC-2)

Friction and Wear Characteristics of Cermets at High Temperature and High Vacuum, by *R. D. Brown, R. A. Burton*, and *P. M. Ku*, Southwest Res. Inst., San Antonio, Texas (ASLE Paper No. 61LC-3)

Session 2 2:00 p.m.

Friction, Wear, and Surface Films

Friction and Surface Deformation During Sliding on a Single Crystal of Copper, by *J. M. Bailey*, Beloit College, Beloit, Mich., and *A. T. Gwathmey*, Univ. of Virginia. (ASLE Paper No. 61LC-4)

Chemical Changes in Steel Surfaces During Extreme Pressure Lubrication, by *D. Godfrey*, California Res. Corp., Richmond, Calif. (ASLE Paper No. 61LC-5)

Extreme Pressure Lubrication and Wear—The Chemical Reactivity and the Extreme Pressure Action of Two Aliphatic Disulfides, by *A. Dorinson* and *V. E. Broman*, Sinclair Res. Labs., Harvey, Ill. (ASLE Paper No. 61LC-6)

Polymeter Formation on Sliding Metals in Air Saturated With Organic Vapors, by *W. E. Campbell*, consultant, Cleveland, Ohio; and *R. E. Lee, Jr.*, Gen. Elec. Co., Schenectady, N. Y. (ASLE Paper No. 61LC-7)

▶WEDNESDAY, OCTOBER 18

Session 3 9:00 a.m.

Properties of Lubricants

Effect of Lubricant Viscosity on Metallic Contact and Friction in a Sliding System, by *M. J. Furey* and *J. K. Appeldoorn*, Esso Res. and Engng. Co., Linden, N. J. (ASLE Paper No. 61LC-8)

Heat of Preferential Adsorption of Surfactants on Porous Solids and Its Relation to Wear of Sliding Steel Surfaces, by *A. J. Groszek*, British Petroleum Co., Ltd., Sunbury-On-Thames, Middlesex, England. (ASLE Paper No. 61LC-9)

Preparation, Properties, and Some Applications of Super-Refined Mineral Oils, by *E. E. Klaus, E. J. Tewksbury*, and *M. R. Fenske*, Pennsylvania State Univ. (ASLE Paper No. 61LC-10)

Dynamic and Static Irradiation of Nuclear Power-Plant Lubricants, by *D. B. Cox, E. A. Oberright*, and *R. J. Green*, Socony-Mobil Oil Co., Paulsboro, N. J. (ASLE Paper No. 61LC-11)

Session 3 Special Topics 9:00 a.m.

Viscous Lubrication in Wire Drawing, by *J. F. Osterle* and *J. R. Dixon*, Carnegie Inst. of Tech., Pittsburgh, Pa. (ASLE Paper No. 61LC-12)

A Study of High-Temperature Oscillating Plain Bearings, by *W. A. Glaeser*, Battelle Memorial Inst., Columbus, Ohio. (ASME Paper No. 61—Lub-2)

Nonlinear Viscosity Effects in Slider Bearing Lubrication, by *C. W. Ng* and *E. Saibel*, Rensselaer Polytechnic Inst., Troy, N. Y. (ASME Paper No. 61—Lub-7)

The Magnetohydrodynamic Slider Bearing, by *W. T. Snyder*, State Univ. of New York, Oyster

ASLE Papers

COPIES of ASLE papers may be ordered by writing to the: ASLE Technical Papers Order Department, 5 North Wabash Ave, Chicago, Ill. Please note that all papers must be ordered by the paper number listed in this program, otherwise the order will be returned. Prices are 50 cents to members of ASLE and 75 cents to nonmembers. **You can save the postage and handling charges by including your check or money order and sending it with your request.**

Bay, N. Y. (ASME Paper No. 61—Lub-10)

Session 4 2:00 p.m.
Rolling Contact and Fatigue

Effects of Base Oil Viscosity and Type on Bearing-Ball Fatigue, by *F. G. Rounds*, Gen. Motors Corp., Warren, Mich. (ASLE Paper No. 61LC-13)

The Effect of Contact Angle on Rolling-Contact Fatigue and Bearing-Load Capacity, by *E. V. Zaretsky, W. J. Anderson*, and *R. J. Parker*, NASA, Lewis Res. Center, Cleveland, Ohio. (ASLE Paper No. 61LC-14)

Weibull Distribution of Rolling-Contact Fatigue Life and Deviations Therefrom, by *T. Tallian*, SKF Industries, Inc., Philadelphia, Pa. (ASLE Paper No. 61LC-15)

The Toroid Contact-Roller Test as Applied to the Study of Bearing Materials, by *W. J. Greenert*, U. S. Naval Engng. Experiment Station, Annapolis, Md. (ASME Paper No. 61—Lub-6)

Session 4 2:00 p.m.
Hydrodynamic Lubrication

Counterrotating Journal Bearings, by *O. Pinkus*• Technical Res. Group, Syosset, N. Y. (ASME Paper No. 61—Lub-9)

On the Optimization of the Stiffness of Externally Pressurized Bearings, by *M. Ling*, The Cincinnati Milling Machine Co., Cincinnati, Ohio. (ASME Paper No. 61—Lub-3)

Experimental Investigation of Oil-Film Behavior in Short Journal Bearings, by *B. Auksmann*, Ingersoll-Rand Co., Phillipsburg, N. J. (ASME Paper No. 61—Lub-11)

Theoretical Contributions to the Study of Gas-Lubricated Journal Bearings, by *Y. Katto* and *N. Soda*, National Aeronautical Lab, Tokyo, Japan. (ASME Paper No. 61—Lub-8)

▶THURSDAY, OCTOBER 19

Session 5 9:00 a.m.
Rolling-Contact Bearings

Evaluation of Ball-Bearing Performance in Liquid Hydrogen at DN Values to 1.6 Million, by *H. W. Scibbe* and *W. J. Anderson*, NASA, Lewis Res. Center, Cleveland, Ohio. (ASLE Paper No. 61LC-16)

Development of a Ceramic Rolling-Contact Bearing for High-Temperature Use, by *K. M. Taylor*, The Carborundum Co., Niagara Falls, N. Y.; *L. B. Sibley*, Battelle Memorial Inst., Columbus, Ohio; and *J. C. Lawrence*, SKF Industries, Inc., Philadelphia, Pa. (ASME Paper No. 61—Lub-12)

ASME Papers

All numbered ASME papers in this program are available in separate copy form until July 1, 1962. Prices are 50 cents to members of ASME, $1 to nonmembers, plus postage and handling charges. Payment may also be made by free coupons, or coupons which may be purchased from the Society in lots of ten at $4 to members; $8 to nonmembers. **You can save the postage and handling charges by including your check or money order made payable to ASME and sending it along with your request to: ASME Order Department, United Engineering Center, 345 East 47th Street, New York 17, N. Y.** Papers must be ordered by the paper numbers listed in this program, otherwise the order will be returned. The final listing of available technical papers will be found in the issue of Mechanical Engineering containing an account of the conference.

Lubrication of Rolling Surfaces by a Ree-Eyring Fluid, by *J. C. Bell*, Battelle Memorial Inst., Columbus, Ohio. (ASLE Paper No. 61LC-17)

Fluid-Lubrication Theory of Roller Bearing, Part 1: Fluid-Lubrication Theory for Two Rotating Cylinders in Contact, by *T. Sasaki, H. Mori*, and *N. Okino*, Kyoto Univ., Kyoto, Japan. (ASME Paper No. 61—Lub-13)

Fluid-Lubrication Theory of Roller-Bearing, Part 2: Fluid-Lubrication Theory Applied to Roller Bearings, by *T. Sasaki, H. Mori*, and *N. Okino*, Kyoto Univ., Kyoto, Japan. (ASME Paper No. 61—Lub-14)

Session 5 9:00 a.m.
Turbulence and Whirl in Bearings

Analysis of Bearings Operating in Turbulent Regime, by *V. N. Constantinescu*, Inst. of App. Mech. of the Rumanian Academy, Bucharest, Rumania. (ASME Paper No. 61—Lub-5)

On the Translatory Whirl Motion of a Vertical Rotor in Plain Cylindrical Gas-Dynamic Journal Bearings, by *C. H. T. Pan* and *B. Sternlicht*, Gen. Elec. Co., Schenectady, N. Y. (ASME Paper No. 61—Lub-4)

Investigation of Whirl in Externally Pressurized Air-Lubricated Journal Bearings, by *W. A. Gross*, IBM Res. Labs., San Jose, Calif. (ASME Paper No. 61—Lub-1)

Session 6 1:30 p.m.
Externally Pressurized Gas Bearings

Analytical and Experimental Study of Externally Pressurized Air-Lubricated Journal Bearings, by *J. R. Lemon*, The Cincinnati Milling Machine Co., Cincinnati, Ohio. (ASME Paper No. 61—Lub-15)

The Design of Externally Pressurized Gas-Thrust Bearings for Maximum Stiffness and Stability, by *D. C. Allais*, IBM Res. Lab., San Jose, Calif., (ASLE Paper No. 61LC-18)

Pressure and Flow Studies of an Experimental Externally Pressurized Gas-Lubricated Bearing, by *G. B. Speen*, ITT Federal Labs., San Fernando, Calif. (ASLE Paper No. 61LC-19)

Analysis and Design of Externally Pressurized Gas Bearings, by *I. Tang* and *W. A. Gross*, IBM Res. Lab., San Jose, Calif. (ASLE Paper No. 61LC-20)

Explosion Hazards, Air-Pollution Problems, and Standardization of Containers—Focal Points in ASME Materials Handling Symposium, Minneapolis, October 17–18

The ASME Materials Handling Division will hold a Bulk Solids Handling Symposium in Minneapolis, Minn., on October 17-18, at the Hotel Pick Nicollet. The program will include 12 technical papers on the transportation, storage, feeding, conveying, and handling of bulk materials. Minneapolis situated as it is in the heart of the grain industry, explosion hazards and air-pollution problems for grain and similar materials will be covered.

Highlighting the program will be the results of the American Standards Association MH-5 Committee work on the standardization of containers for interchangeability between truck, rail, and ship movements.

The ASME Minneapolis Section is host to the conference, and has activities planned for the women as well as the men. An inspection tour will be made of the Cargill, Inc., grain storage and handling installation at Savage, Minn. This includes a six-million bushel grain-storage elevator; truck, rail, and barge loading and unloading facilities. Also included in the tour is a visit to the Northern States Power Company Black Dog Station to view their coal-handling operation. Get-acquainted luncheons are scheduled for both days of the conference.

▶TUESDAY, OCTOBER 17

Session 1 9:30 a.m.

Special Hopper Cars for Bulk Shipments of Materials, by *Le Roy Kramer, Jr.*, General American Transportation Co., Chicago, Ill. (Paper No. 61—MH-2)

Bulk Trailer Transportation,[1] by *G. J. Korbelik*, Butler Mfg. Co., Kansas City, Mo.

Container Standardization for Truck, Rail, and Ship-Container Sizes,[1] by *H. H. Hall*, American Standards Association, Pittsburgh, Pa.

Session 2 2:30 p.m.

Design and Application of Precast Concrete Stave Silos, by *H. D. Webb*, American Marietta Co., Marietta, Ohio (Paper No. 61—MH-3)

Recent Developments in Bulk Materials Handling,[1] by *L. O. Millard*, Link Belt Co., Chicago, Ill.

Availability of Papers

Only numbered ASME papers in this program are available in separate copy form until Aug. 1, 1962. The final listing of available technical papers will be found in the issue of Mechanical Engineering containing an account of the conference. Prices are 50 cents to members of ASME, $1 to nonmembers, plus postage and handling charges. Payment may also be made by free coupons which may be purchased from the Society in lots of ten at $4 to members; $8 to nonmembers. **You can save the postage and handling charges by including your check or money order made payable to ASME with your order and sending both to: ASME Order Department, 345 East 47th Street, New York 17, N. Y.** Papers must be ordered by the paper numbers listed in this program, otherwise the order will be returned.

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[1] Paper not available—see box on this page.

Getting Difficult Materials out of Bins,[1] by *A. D. Sinden*, Stephens-Adamson Mfg. Co., Aurora, Ill.

▶WEDNESDAY, OCTOBER 18

Session 3 **9:30 a.m.**

Selection and Application of Continuous Weigh Feeders, by *A. G. van Stolk*, and *D. R. Boeck*, Wallace and Tiernan, Inc., Belleville, N. J. (Paper No. 61—MH-5)

Automation and Control of Proportioning Systems, by *I. M. Richardson*, Richardson Scale Co., Clifton, N. J. (Paper No. 61—MH-4)

Air-Pollution Considerations in Bulk-Handling Operations,[1] by *M. E. McLouth*, air-pollution control engineer, City of Minneapolis, Minneapolis, Minn.

Session 4 **2:30 p.m.**

Explosion Hazards in Bins and Conveying Systems, by *R. W. Olson*, Mill Mutual Fire Prevention Bureau, Chicago, Ill. (Paper No. 61—MH-1)

Design and Application of the Closed Loop Pneumatic Conveyer System,[1] by *H. Young*, Young Machinery Co., Muncy, Pa.

Materials Handling in Power-Plant Operation,[1] by *Vincent Frawley*, Northern States Power Co., St. Paul, Minn.

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[1] Paper not available—see box on page 103.

Automation in Textile Industry Is Theme of ASME Textile Conference at M.I.T., November 1–2

Automation and its potential for the textile industry will be the subject of the ASME Textile Conference to be held at the Little Theatre, Kresge Auditorium, Massachusetts Institute of Technology, Nov. 1-2, 1961. Lowell Technological Institute and the Textile Division of the M.I.T. Mechanical Engineering Department will serve as co-hosts of the conference.

The program formulated under the chairmanship of K. R. Fox, Mem. ASME, of Fabric Research Laboratories, Dedham, Mass., consists of three technical sessions and arrangements for plant and laboratory inspection trips.

The first session will be devoted to engineering aspects of process control emphasizing problems in the dynamics of processing and in material-process interactions. The section session, entitled applications of automation to textile operations, will present the approach of the spinner and weaver, the cloth finisher, and the machinery manufacturer to automation in textile production. Techniques useful in an automated textile organization will be considered in the third session with papers on computer applications, control techniques, and operations research. A general lecture is scheduled to cover selection and training of personnel for the automated mill.

Conducted for
the National Junior
Committee

STEWART H. ROSS[1]

JUNIOR FORUM

Speed Reading

> *"Reading maketh a full man, conference a ready man, and writing an exact man."*—Francis Bacon

Like the hula-hoop and the yo-yo, speed reading has become an overnight fad. But unlike the dust-gathering novelties that preceded it, this more scientific approach to reading has been a long time in coming—and is certain to leave a permanent mark.

The current excitement in speed reading harks back to the "reading improvement" programs begun as education experiments during the 1920's. Objectives were, and still are, to help people get more out of what they read and to increase speed—by emphasis on efficient organization during reading, by "idea" reading, and by vocabulary building. In response to the clamor, reading courses are now given at leading companies, universities, and government organizations (all to packed classes) and self-improvement books have become big sellers.

A panacea to the busy engineer, this speed reading? An unqualified yes! But there are no easily memorized or handbooked formulas. Reading skill comes with reading practice, applying new techniques—plus the conscious, continuous unlearning of "word" reading habits acquired in grammar school.

This first article will sketch the history of speed reading, talk a little about the reading mechanism itself, and discuss the engineer and his reading tasks and what he has to gain by being able to read more skillfully. You will be asked to determine your own reading rate and you will be quizzed to check comprehension. Presumably your appetite will then be sufficiently whetted for you to look forward to a subsequent article dealing specifically with the techniques of speed reading. Hopefully, you will then embark on a self-improvement reading program of your own, or enroll in a formal course on the subject.

Recognition of the benfits to accrue to the person who reads quickly and accurately—and the limitations of the word-by-word recognition-assimilation method by which we all learn to read—is not solely a by-product of the enormous increase in written communications in the past decade. In 1929, for example, Walter B. Pitkin wrote "The Art of Rapid Reading—a book for people who want to read faster and more accurately." But we must go back in time to 1879, when researchers first began to study the relation between eye movements and reading. What do the eyes do as they follow lines of print? If improvement in reading skill is to be made, the mechanism first must be understood.

Eye-Movement Photography. Using a telescope to magnify eye movements, the earliest observers peered through a hole in the page the subject was reading. Others used a mirror to try to catalog eye motion by watching the reflection. One researcher even fixed a pneumatic capsule against his subject's eye ball so that eye motion compressed the capsule and moved an indicator. Sound also was used in attempts to record how eyes moved during reading; a small microphone was attached to the upper eyelid and the diagnostician listed to the movements of the eye.

But it was not until 1905, when Dr. Charles Judd put a speck of white paint on the cornea of his subject's eye and took motion pictures, that meaningful plots were made. Dr. Raymond Dodge's co-ordinately developed corneal reflection method, based on reflection of a narrow beam of light, overcame the obvious drawback of painting subjects' eyes. With the subsequent development of the ophthalmograph in the 1930's, eye-movement photography came into widespread use.

The Reading Mechanism. Modern eye photography shows conclusively that all readers take discrete visual "bites" or fixations as they read. The only time the eyes can "read" is when they pause and observe words not in relative motion. Even the fastest, "smoothest" readers must pause. The average adult, reading a ten word line, makes from eight to ten fixations, while a grammar-school child pauses about 15 times. A superior reader will make perhaps four or less fixations, "seeing" two to three words per pause.

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[1] Proposals writer, Product Information Operation, General Electric Company, Pittsfield, Mass. Assoc. Mem. ASME.

Almost all readers make some regressions—or same-line rereading. Better readers, however, make few regressions. Readers regress because of simple habit, lack of confidence, and the need to double-check constantly, or because of a feeling of misperception of what originally was read. Comprehension studies indicate, however, that even for the poor reader, regressions add little but confusion to the thought-transfer process.

It is important to distinguish between regression and the more conscious act of rereading, or returning to a previously read sentence or paragraph. When rereading is caused by lack of attention, organization, or confidence, rereading is a time-waster. However, for the engineer, rereading often is a necessary means of assimilating heavily detailed information.

Engineer Statistics. A study of adult American reading habits yields some interesting numbers. About 15 per cent of adults have failed to improve their reading skills beyond the fourth-grade level, the last period of formal reading training for most. And 50 per cent of the population reads no better than the normal seventh-grade student.

Where does the engineer fit into this gloomy picture? The average engineer is an inefficiently slow reader, hobbling along at about 250 wpm. Surprisingly, he is no better a reader than the average American male with less education. Yet engineers as a group read more, depend more on written communication; reading is vital to the engineer's on-the-job performance.

Young engineers should spend at least five hours a week reading material—trade journals, texts, company reports—directly connected with their profession. One large company has made a study of the reading habits (reading of every kind) of all its engineers: three hours a day, average, and the higher the engineer's responsibility level, the more he reads. The exploding growth of "should-read" information imposes a further reading load on engineers already bleary-eyed from "must-read" written material.

Speed and Comprehension. But is speed reading the answer to the engineer's mounting reading burden? Aren't details so important to the engineer that he cannot hurry his reading?

Agreement is unanimous among speed reading authorities—and test results prove it—that fast readers also are superior in comprehension. In rapid reading, there usually is greater concentration (there must be!) and less time for dawdling.

Now, please turn to G. H. Zenner's article (1600 words) on cryogenics, pp. 39–42. Read the article at normal speed and with normal attentiveness. Time yourself and compute your speed in wpm. If your rate is 200–250 wpm, you are an average reader; less than 150 wpm classifies you as a plodder, and startlingly in need of improvement; a 400–500 wpm rate distinguishes you as a superior reader. But you must score 70 per cent or better in the following quiz (answers are at the end) to match your comprehension and idea retention with your speed. A score below 60 per cent indicates you probably are an unskilled reader, even if your rate is satisfactory.

(1) In the separation of air, where components have boiling points close together,———is important.

a. fractional condensation
b. distillation
c. absorption

(2) The most important industrial gas is———.

a. hydrogen
b. nitrogen
c. oxygen

(3) The von Linde cycle shows that the maximum amount of liquid oxygen is produced when about———of the air at 2200 psi is expanded through the engine.

a. 25%
b. 50%
c. 75%

(4) Liquid oxygen and liquid nitrogen have been widely used in industry for more than———years.

a. 25
b. 30
c. 35

(5) Prior to development of SI-type insulation, storage of certain gases was made in vessels of———concentric shells.

a. two
b. three
c. four

(6) The author defines cryogenics as concerned only with operations below———.

a. −230 F
b. −250 F
c. −260 F

(7) Carl von Linde first separated oxygen from liquid air on a commercial scale in———.

a. 1902
b. 1904
c. 1912

(8) The power cost of producing gaseous oxygen is about———that of producing liquid oxygen.

a. 30%
b. 50%
c. 75%

(9) To achieve the volume reduction by simple gas compression obtained by liquification of the commercially important gases, pressures of the order of———are required.

a. 3000 psi
b. 30,000 psi
c. 70,000 psi

(10) Liquid———is employed as the heat shield in concentric-shell liquid-gas vessels.

a. helium
b. hydrogen
c. nitrogen

Answers. 1.-b, 2.-c, 3.-b, 4.-a, 5.-c, 6.-b, 7.-a, 8.-a, 9.-b, 10.-c

Members of the ASME National Junior Committee, wives, and guests are shown at the committee's summer meeting in July at The Jug End Barn, South Egremont, Mass.

INSIDE ASME

First Appearance

This first appearance of "Inside ASME," inaugurates what we hope will be a useful and stimulating avenue of communication between the Society and its 60,000 members (50,000 practicing members, and 10,000 student members). From month to month, we intend to take you behind the scenes, showing you the Society in operation.

Professional Departments

In the August issue of Mechanical Engineering, page 102, you learned of the new grouping of Divisions into Departments for closer and more effective leadership of the Divisions. The four Departments have been organized and their Committees appointed.

The men on these Committees are veterans of ASME, working without pay to improve and carry on the Society operation. They will try to anticipate your professional and technical needs.

Where do you personally fit into this picture? In our August issue we printed a chart showing which of our Divisions belong in each Department. As a Member, you have, at some time, indicated three Divisions in which you are especially interested, and you are on the mailing list to receive the bulletins of those Divisions. If your interests have changed, send in the information blank, "Keep your records up to date," on page 110, and let us know.

You have two points of personal contact with your Society. One is the Region, with its Sections. The other is the Professional Division (such as Aviation, Machine Design, Metals Engineering, Nuclear—there are 24 Divisions and two Groups). Through these elements, you should be getting the information you need, meeting the engineers you ought to know.

The Departments have been set up to co-ordinate the Divisional operations and make the Conferences more convenient and more rewarding.

Meetings

When you arrive at the registration desk at a Meeting or Divisional Conference of ASME, you may well ask who did the long and backbreaking task of planning, organizing, and implementing such a complex event. Who made the decisions, who signed the orders, who got the show on the road? Back of it all is ASME's Meetings Committee.

Question: Should members pay a fee for attendance at the Winter Annual Meeting? Nonmembers always have paid fees. In other societies, members pay fees at general meetings. Underlying this is the question: Should the Meeting be self-supporting?

If the Board on Technology approves a Regional Delegates Conference recommendation, members will pay a fee of $5 at the next Winter Annual (Nov. 26–Dec. 1, 1961), with the following exceptions: Ladies, Student Members, immediate family of Members, and distinguished guests invited by the President or Secretary. The fee for student nonmembers will be $1. Nonmembers who are authors of papers, chairmen, vice-chairmen, and invited discussers will be admitted at the member rate. Members of ARS, EIC, I.Mech.E., societies with membership in EJC and ECPD, and other societies listed as cosponsors in the program will be admitted at the member rate.

Problem: West Coast meetings. In the past, the Summer Annual Meeting has been held on the West Coast every fourth year. But the Summer Annual will henceforth be a "Committee Week," devoid of technical sessions. What about the needs of West Coast members?

The answer lies in the increased number of Professional Division Conferences being held west of the Rockies. A recommendation by the Meetings Committee, that a West Coast Meetings Committee be formed, was well received by Western representatives. The West Coast Sections will be advised as to the area of responsibility and scope of such a committee so that they can decide on the action they should take.

Research

Maybe you weren't aware that your Society plays an important role in engineering research. It does. The purpose is to undertake research that no individual company could justify by itself—no immediate profit possibilities. Such research must be of value to the entire profession. ASME sponsors the project, obtains contributions from many companies—in money, men, or laboratories—and the research is performed. Results are published. The publication of research results is an absolute must.

If you had been a member of the Research Planning Committee, here are items you'd have considered during a recent meeting:

The Fluid Meters Committee has three active projects. First is the project on High Pressure and High Temperature Steam Flow Measurements being conducted at the Naval Boiler and Turbine Laboratory in Philadelphia. There is the work on Quadrant Orifices being conducted at Cornell University. There is a project on The Effect of Compressibility on Area Meters (Rotameters). A project on Pulsating Flow is in the planning stage, expected to be at Stanford Research Institute.

As of now, there are 20 research committees, calling on the services of some 800 people, operating with an annual budget of approximately $175,000.

And, in the entire Society, there are something like 5000 committee posts held by members, serving the profession by arranging the meetings and conferences, reviewing technical papers, deciding on and carrying out special projects, developing codes and standards, determining policy.

Suppose . . .

You were a member of the Publications Committee.

How would you decide this one? The Editor reports that $2400 per year can be saved by eliminating the wrappers from Mechanical Engineering, mailing them with only a sticker attached to the front cover. Most consumer magazines, such as *LIFE*, mail without wrappers. Does the wrapper make you happy $2400-worth? How would you vote?

—*Maurice Barrangon.*

Actions at the ASME Council Meeting, June 11–12, 1961

THE Council met in three open sessions during the Summer Annual Meeting of the Society in the Statler Hilton Hotel, Los Angeles, Calif., on Sunday, June 11, 1961, at 9:45 a.m., convening in Executive Session from 10:40 a.m. to 1:10 p.m., reconvening at 2:10 p.m. and adjourning at 4:05 p.m.; and on Monday, June 12, 1961, at 9:30 a.m. and adjourning at 11:15 a.m.

There were present (at all sessions unless otherwise noted) the following:

The Council. President William H. Byrne; Vice-Presidents: D. J. Bergman, C. H. Coogan, Jr.; E. H. Draper, Harold Grasse, W. C. Heath, A. H. Jensen, D. E. Marlowe, H. N. Muller, R. C. Robertson, and G. B. Thom. Directors: E. O. Bergman, R. G. Folsom, C. C. Franck, Sr.; J. B. Jones, A. M. Perrin, R. B. Smith, and R. S. Stover. E. M. Barber and L. N. Rowley were excused because of other commitments. Past-presidents: J. N. Landis. W. L. Cisler and G. B. Warren were excused. Treasurer: E. J. Kates, and Secretary, O. B. Schier, II.

Former members of the Council. J. C. Brown (Sunday afternoon and Monday morning), V. A. Peterson (Sunday afternoon), and C. H. Shumaker (Sunday afternoon).

Chairmen and Members of Boards and Committees. Constitution and By-Laws, T. A. Wetzel and T. N. Graser (Sunday); Constitution Revision Subcommittee, G. M. Muschamp (Sunday morning); Organization Committee, E. H. Hanhart; Board on Membership, W. E. Belcher, Jr. (Sunday); Technical Development, R. C. Allen (Sunday afternoon); National Agenda Committee, J. D. Carr (Sunday afternoon) and M. B. Hogan; National Nominating Committee and Alternates, W. E. Belcher, Jr.; R. G. Critz, T. C. Heyward, Jr.; J. H. Hitchcock, A. K. Ingraham, J. R. Muenger, and K. M. Wilson (Sunday), J. M. Zilboorg (Sunday morning), C. B. Briscoe, Ray Hollaway, G. V. Minniberger, C. G. Parker, and R. D. Reese (Sunday afternoon); Regional Delegates, B. G. Barr, E. G. Chilton, C. M. Irwin, C. E. Redfern, and C. E. Evanson (Sunday morning), Michael Bezbatchenko, P. A. Bissonnette, A. J. Clark, Jr.; G. B. DeHoff, B. D. Howell Thomas Howitt, Jr.; M. E. Jansen, W. H. Kohler, Emmart LaCrosse, Jr.; Stanley Lovejoy, Edward Miller, Richard Neuendorffer, G. E. Pankratz, J. W. Swan, and F. A. Thomas, Jr. (Sunday afternoon), and J. W. Ott (Monday morning).

Guests. T. A. Marshall, Jr. (Sunday morning), Robert Nelsen and John Parmakian (Monday morning), and H. H. Snelling.

Staff. Assistant Secretaries, W. H. Larkin and W. E. Reaser; Controller, H. I. Nagorsky; Associate head, Field Department, D. B. MacDougall; Public Relations Director, L. S. Dennegar (Sunday); Meetings Manager, A. B. Conlin (Sunday); Associate Editor, Maurice Barrangon.

Constitution and By-Laws Committee. ***Revision of the Constitution, By-Laws, and Rules.*** The Council votes (*a*) to approve the proposed revision of the Constitution, By-Laws, and Rules as submitted by the Committee, and (*b*) to submit to the Business Meeting, June 12, 1961, those amendments dealing with the transposition of By-Laws to Constitution status and transposition of Constitution to By-Law status and to submit these to the entire membership for letter ballot.

Amendment to the Constitution. The Council voted to submit to the Business Meeting, June 12, 1961, a constitutional amendment in accordance with provisions of Article C16, Section 1, for discussion and modification and a vote as to whether the proposed amendment to Article C4, Section 7 of the Constitution, shall be mailed in printed form to the members of the Society for action.

Amendments to the By-Laws. The Council voted (*a*) to adopt the amendments to Article B3, Pars. 2, 3, 4, 5, and 6; Article B4, Par. 8; Article B6A, Pars. 7, 14, 14-C, 14-C1, 15, 15-B (new), 15-B, 15-C, 15-D, 17-B, and 21 (new); Article B6B, Par. 1; Article B7, Par. 1; and (*b*) to receive for first reading the proposed amendments to Article B6A, Par. 16.

Amendments to the Rules. The Council voted to approve the amendments to the following Rules: Article R10, Rules 1, 3, 4, 9, 11, and 12. The following Rules, approved by the Council on Nov. 27–28, 1960, Article R5, Rules 2 and 3 became effective June 11–12, 1961, when related By-Laws were adopted.

ASME Council Time Schedule. ***New Council Organization Meeting.*** The Council at its organization meeting, Nov. 28, 1960, adopted the revised Time Schedule—ASME Council. At its meeting on Feb. 2, 1961, the Organization Committee recommended that the full Council reconsider its action and consider the Time Schedule proposed by the Organization Committee. The Council voted (*a*) to rescind the action taken on Nov. 28, 1960, and (*b*) to adopt the Time Schedule—ASME Council as amended.

Board Honors. ***Max Jakob Medal and Award.*** The Council voted to approve the establishment of the Max Jakob Medal and Award according to the terms stated in the revised Deed of Gift.

Max Jakob Medal and Award—1961 Recipient. The Council noted that Dr. Ernest R. G. Eckert, professor of mechanical engineering, director of the Heat Transfer Laboratory, University of Minnesota, has been elected as the first recipient of the Max Jakob Medal and Award.

Board on Technology. ***Instruments and Regulators Division.*** The Board on Technology, on recommendation of the Professional Divisions Planning Committee, authorized the change of name of the ASME Instruments and Regulators Division to Automatic Control Division.

Research Executive Committee. ***International Conference on Properties of Steam Secretariat.*** The Council authorized the transfer of $2500 from the Research Operation Reserve (G-53) to the General Research Fund (G-37) for the continuing operation of the Office of the Executive Secretary of the U. S. A. Commission on Properties of Steam.

Research Agreement 37-1. The Secretary signed Research Agreement 37-1 with the University of Michigan covering the period Nov. 1, 1960, through Oct. 31, 1961, for work sponsored through the Subgroup of Metals Engineering of the Subcommittee on Ferrous Materials and High Temperature Alloys of the ASME Boiler and Pressure Vessel Committee, with a total expenditure not to exceed $2000. Sufficient funds, especially allocated from the Edison Electric Institute to cover this expenditure, are in the General Research Fund.

Department of Water and Power of the City of Los Angeles. The Secretary signed an agreement, dated April 19, 1961, whereby the Department of Water and Power of the City of Los Angeles will contribute $990 in continuing support of the work of the Research Committee on Properties of Steam.

Supplements to Research Agreements. The Secretary signed Supplement No. 5 to Research Agreement 7SP-5 and Supplement No. 4 to research Agreement 7SP-6 with the University of Michigan for work sponsored by the ASTM-ASME Joint Committee on the Effect of Temperature on the Properties of Metals both of which included the following change in wording: 10(*c*) ". . .plus [delete: 24% of the expenditures for salaries and wages] 15% of all costs on account of overhead allocable to the research."

Sections. ***West Texas Section.*** The Council authorized Section status for the Tarrant County Subsection of the North Texas Section to be known as the West Texas Section with headquarters in Fort Worth, Texas; the territory to be bound on the north by Montague, Clay, Wichita, Wilbarger, and Hardeman counties; on the west by Foard, Knox, Haskell, Stonewall, Kent, Garza, Lynn, Terry, Yoakum, Gaines, Andrews, Winkler, and Loving; southeast along the Pecos River to the Rio Grande River and then on the south by Kinney, Edwards, Kimble, Mason, San Saba, and Lampassas; and on the east by Coryell, Bosque, Johnson, Tarrant, and Wise counties.

Memphis and Midsouth Group of the Chattanooga Group. The Council authorized the formation of the Memphis and Midsouth Group of the Chattanooga Section with headquarters at Memphis, Tenn., and the territory to include the following Tennessee counties: Shelby, Fayette, Hardeman, Haywood, Tipton, Crockett, Gibson, Dyer, Lake Lauderdale, and Obion.

Mississippi Group of the Birmingham Section. The Council authorized the formation of the Mississippi Group of the Birmingham Section with headquarters at Jackson, Miss., and the territory to include the following counties of Mississippi: Monroe, Humphreys, Noxubee, Quitman, Choctaw, Kemper, Sunflower, Warren, Smith, Webster, Scott, Washington, Winston, Yalobusha, Attla, Newton, Bolivar, Yazoo, Jasper, Montgomery, Rankin, Jefferson, Leake, Calhoun, Carroll, Neshoba, Coahoma, Sharkey, Clarke, Grenada, Hinds, Copiah, Claiborne, Chickasaw, Holmes. Loundes, Tallahatchie, Oktibbeha, Lauderdale, Leflore, Madison, Simpson, and Clay.

ASME Organization Study. ***Report.*** E. H. Hanhart, chairman of the Organization Committee, reported to the Council on the findings and proposals of Cresap, McCormick and Paget as represented in their report entitled, "Study of (ASME) Membership and Services in a Changing Technology," and how these findings were being implemented under the direction of the Organization Committee. The Council voted to receive the progress report on the implementation of the study.

ASME Emblem. ***Permission to Use.*** The Council authorized the Atlanta Section to use the ASME emblem on the certificate to be awarded to the graduating mechanical-engineering senior outstanding in scholarship and leadership.

Annual Report. The Council (*a*) authorized the preparation of an Interim Report of the Society which will appear in the December, 1961, issue of MECHANICAL ENGINEERING; and (*b*) to resume the distribution of the Annual Report to all members of the Society as a supplementary edition to MECHANICAL ENGINEERING after June 30, 1962.

1961 Regional Delegates. ***Recommendations.*** The Council voted (*a*) to receive the report of the 1961 Regional Delegates Conference; (*b*) to refer the recommendations to the committees concerned for report to the Executive Committee of the Council in September; and (*c*) to express sincere appreciation to the Regional Delegates for their efforts on behalf of the Society. President Byrne presented each Regional Delegate with a certificate.

High Limit Accident Insurance. ***Report.*** E. J. Kates, chairman of the Group Disability Insurance for ASME Members Committee, reported that the high Limit Accident Insurance which was offered to the members in the spring of 1961 has been well received.

Fulton Memorial. ***Restoration of Bronze Plaque.*** The Council authorized the Secretary to have the bronze replica of the Claremont's plans restored at a cost not to exceed $200.

Intersociety Relations Committee. ***Report.*** R. B. Smith, chairman of the ASME Intersociety Relations Committee, reported that meetings have been held during the year with representatives of the Founder Societies and other societies in ECPD and EJC. Though the Committee is approximately six months behind the schedule set last June, it hopes to make recommendations to the Council this fall.

Member Gifts Campaign. ***Report.*** W. H. Larkin reported on progress made in the Member Gifts Campaign in the past six months and announced that in accordance with the program arranged by the Special Committee of the Council the last of the letters to the entire membership from President Byrne are being mailed.

International Heat Transfer Conference. ***Russian Delegation.*** The Council authorized the expenditure of up to $1000 from the "A" Development Fund to cover the expenses incurred by W. H. Larkin in

Call for Agenda Items for 1962 RAC Meetings

THE 1962 Agenda Committee extends an invitation to every member of ASME to offer suggestions and improvements in the operations of the Society. This invitation is a step in the democratic process by which the membership and the Sections impart their ideas to the Council.

Please word your proposed items so that they are clear and specific and so that there will be no misunderstanding as to intent. Also, be sure the wording is positive so that action can be taken either to "accept" or "reject" the item as worded. Accompany each item with a short statement as to why you feel the item should be approved.

All agenda items are to be submitted in accordance with the following form, *and should be sent to the Secretary of your Section not later than Oct. 1, 1961.*

The Agenda Committee of each Section will screen these items against items previously considered by the Council, and forward the items to the National Agenda Committee not later than Nov. 1, 1961.

If you lack the address of your Section Secretary, you may send your items, *not later than October 1, to the ASME Agenda Committee, United Engineering Center, 345 East 47th Street, New York 17, N. Y.*

ASME Agenda Item

Proposed by . . . . of the . . . . Section

Address . . . .

Date . . . .
Signature

Item: It is proposed that . . . . .

Proposer's Comment:

acting as host to the Soviet delegation at the International Heat Transfer Conference Aug. 28–Sept. 1, 1961, at Boulder, Colo.

Proliferation of Meetings. *Area of Flight Sciences.* Harry F. Guggenheim, president of the Guggenheim Foundation, invited representatives of SAE, ASME, ARS, and IAS to discuss the proliferation of meetings in the area of the flight sciences. Four meetings have been held to determine what course of action might be followed to co-ordinate the meetings currently being sponsored by these societies. Charles Savage, who serves EJC in the general area of co-ordination of meetings, is also a member of this committee.

Deceased Member. *John M. Lessells.* The Council noted with sympathy the death of John M. Lessells, Hon. Mem. ASME, on Wednesday, May 17, 1961. (See Editorial, MECHANICAL ENGINEERING, July, 1961, pp. 25–26.)

Certificates of Award. *Codes and Standards:* S. W. Meldram, B56 Section Committee.

Faculty Adviser: W. T. Triffin, University of Florida Student Section, 1948–1952 and 1957–1961.

Retiring Section Chairman: D. R. Craig, Columbus; J. W. Miller, Ontario; E. R. Friesth, Iowa-Illinois; T. H. Fetter, Jr., Philadelphia; and A. P. Gnann, Jr., Savannah.

Appointments. *Honorary Vice-President.* Hilding V. Tornebohm, June 7–8, 1961, at the 100th Anniversary, Svenska Teknologföreningen, Stockholm, Sweden.

Executive Session of the Council.

The members of the Council met in executive session on Sunday, June 11, 1961, at 10:45 a.m., adjourning at 1:10 p.m. and reconvening at 9:00 a.m. on Monday, June 12, adjourning at 9:30 a.m.

There were present: President William H. Byrne; Vice-Presidents: D. J. Bergman, C. H. Coogan, Jr.; E. H. Draper, Harold Grasse, W. C. Heath, A. H. Jensen, D. E. Marlowe, H. N. Muller, R. C. Robertson, and G. B. Thom; Directors: E. O. Bergman, R. G. Folsom, C. C. Franck, Sr.; J. B. Jones, A. M. Perrin, R. B. Smith; and R. S. Stover; Past-president: J. N. Landis; Treasurer E. J. Kates; and Secretary O. B. Schier, II.

Board on Honors. *Election of Honorary Members.* The Council unanimously elected as Honorary Members of the Society: Sanford L. Cluett, Troy, N. Y.; Willis F. Thompson, New Haven, Conn.; and Frederick H. Rolt, Hampton, Middlesex, England.

Appointments. *Assistant Secretary.* The Council voted to appoint W. H. Larkin as assistant secretary for the term ending June 12, 1962.

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

THE application of each of the candidates listed below is to be voted on after Sept. 25, 1961, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and Promotions

Arizona

Nickell, Hershell A., Phoenix

California

•Atwood, Stanley G., Jr., Hawthorne
Cartwright, James H., Long Beach
Halkin, Hubert R., Palo Alto
Hatcher, Grover C., Jr., Torrance
Hunton, Fred W., Lafayette
Judge, Thomas J., Jr., San Jose
McAllister, A. Stratton, San Jose
Stern, Peter M., Whittier
Stripling, Lee B., Woodland Hills
•Tippets, Frank E., Santa Clara

Colorado

Heimerich, George R., Denver
Meyer, Greg C., Wheat Ridge
Russell, Robert M., Denver
Seneviratne, Maddumage, Denver

Connecticut

•Abercrombie, Ralph D., Orange
Rowe, George H., 3rd, Windsor Locks
Ruth, Robert L., Waterbury

Florida

Elkins, Kenneth L., Orlando
Fenn, Joe D., Pensacola
•Wilharm, Fred B., Pensacola

Georgia

Bradburne, John C., Jr., Decatur
Cline, Bobby L., Dalton
Johnson, Daniel M., Atlanta
White, Edward F., Savannah

Idaho

•Schulz, Elmer A., Jr., Idaho Falls

Illinois

•Bushnell, Cornelius H., Jr., Crete
Martin, Edward J., Park Ridge
Matti, Leo F., Rockford

Iowa

•Stahler, Carl R., Davenport

Louisiana

Germany, Charles J., Monroe

Maryland

•Cannon, James P., Baltimore
Horstman, Douglas F., Baltimore
•Hutter, Russell G., Baltimore
•Meyer, Carl W., Baltimore
Wise, Walter R., Jr., Silver Spring

Massachusetts

•Bowman, William J., Dedham
•Gertel, Maurice, Chestnut Hill

Michigan

Jack, Daniel A., Battle Creek

Minnesota

•Isaak, Vernon L., Minneapolis

Missouri

Franco, Robert T., Richards-Gebaur AFB
Kinman, Wayne D., St. Louis

New Jersey

Hennesser, Hannes B. P. R., Haddonfield
Oliver, Paul E., W. Englewood

New Mexico

Carpenter, Charles L., Albuquerque
•Stone, Porter W., Holloman AFB

New York

Alweil, Richard H., Hewlett
Curtis, Donald N., Rochester
Fox, Stanley, Jamaica
Green, George K., Geneva
•Helve, John H., Burnt Hills
Katz, Donald, Flushing
Lang, Lee S., Rochester
Leibowitz, Herman, New York
•Leonard, Edward S., Olean
Meissner, Harold G., Mt. Vernon
Miller, Earl J., New York

Ohio

•Coulter, Earl E., Alliance
Snow, Robert W., Cincinnati
Trainer, Thomas M., Columbus

Pennsylvania

Biswas, Sujit K., Pittsburgh
Danies, Enrique E., Pittsburgh
•Forscher, Frederick, Apollo
Harris, LeRoy S., Cornwells Heights, Bucks County
Peters, Eugene J., Scranton
Petsinger, Robert E., Pittsburgh
Vogel, John A., Pittsburgh
Waller, John F., Philadelphia
•Weaver, Joseph M., Pittsburgh

Tennessee

•Akers, Walter S., Elizabethton
Chandler, Harold K., Kingsport
John, Richard A., Memphis

Texas

Brooke, Chase J., Jr., San Antonio
Infante, Ettore F., Austin
Jefferies, Robert K., Waco
•Zanowiak, Paul P., Sweetwater

• Promotion to Member or Affiliate.

Utah

Miller, Leon, Jr., Brigham City

Vermont

Grobey, Paul A., Springfield

Virginia

Stanek, Lawrence J., Lynchburg
Will, Robert K., Blacksburg

Washington

Harvey, John R., Bellevue
Stevens, Walter O., Mercer Island

Foreign

Ambrosini, Giancamillo, Varese, Italy
Arthur, A. Bernard, Rexdale, Ont., Canada
Barabaschi, Sergio, Varese, Italy
Davies, Glyn B., Tredegar, Mon., England
Harp, Ernest J., Judibana, Falcon, Venezuela
•Jain, Surendra K., Bombay, India
Naik, Shrinivas, S., Rourkela, Orissa, India
Ripper Neto, Arthur P., Rio de Janeiro, Copacabana, Brazil
Tedeschi, Francesco, Milan, Italy
Thompson, Kenneth C., Durban, South Africa

OBITUARIES

Eric Goodwin Johnson (1882–1961), retired, superviser, School of Industrial Arts, Trenton, N. J., died May 14, 1961. Mem. ASME, 1921.

Roy Edwin Johnson (1889–1961), president, Arenco Machine Company, Inc., New York, N. Y., died May 19, 1961. Jun. ASME, 1925; Assoc-Mem. ASME, 1928; Mem. ASME, 1934.

Armin George Kessler (1886–1961), consulting engineer, Hudson, Ohio, died May 30, 1961. Assoc-Mem. ASME, 1909; Mem. ASME, 1925. He was member of Sigma Xi and Tau Beta Pi.

Roy Nobutatsu Kurosawa (1934–1961), mechanical engineer, Maintenance (Weapon) Division, Sacramento Air Material Area, SMAHA, McClellan Air Force Base, Sacramento, Calif., died March 22, 1961. Assoc. Mem. ASME, 1957.

Murray Lopatin (1928–1960), design engineer, Loewy-Hydropress Division, Baldwin-Lima-Hamilton Corporation, New York, N. Y., died April 29, 1960. Assoc. Mem. ASME, 1951.

George Manierre (1876–1961), owner, Manierre Engineering & Machinery Company, Milwaukee, Wis., died Dec. 10, 1960. Mem. ASME, 1917. His patented inventions included box car loaders and unloaders, chutes, and warehouse conveyers.

John Andrew Miller (1872–1961), who had been president of Dexter Portland Cement Co., Clinchfield Portland Cement Co., and Albion Slate Co., retired engineer; Nazareth, Pa., died April 11, 1961. Mem. ASME, 1913.

Lucian Barclay Moody (1882–1961?), retired Colonel, USA, and consulting engineer, Washingon, D. C., died recently according to a notice received by the Society. Mem. ASME, 1946. Member U.S. Production (Nelson) Mission to China, 1945. He held a few automotive patents to protect U. S. Government rights.

Thomas Edward Murray (1891–1961), president, Metropolitan Engineering Company, Brooklyn, N. Y., and consultant since 1957 to the Joint Committee on Atomic Energy, died May 26, 1961. Mem. ASME, 1932; Fellow ASME, 1947. He authored the article "Reliance on H-Bomb and Its Dangers," published in *Life* magazine, May 6, 1957. Fellow of AIEE. A businessman and inventor, Mr. Murray was appointed to the Atomic Energy Commission by President Truman to fill the unexpired term of David E. Lilienthal and later was appointed to a full five-year term. He favored liberalizing the classification of weapons-effects information, advocated the development of small, tactical atomic weapons, and strongly opposed including them in the scope of the weapons-test moratorium. He attached special significance to the foreign implications of an energetic nuclear power program and, although not a partisan of public power, he favored AEC's undertaking an extensive program of prototype plant construction. He was an outspoken critic of the Dixon-Yates contract involving the AEC and the Mississippi Valley Generating Company. He was a member of the AEC from 1950 to 1957. He was granted about 200 patents, and held honorary degrees from St. John's University, Georgetown University, Fordham University, Marquette University, and the Polytechnic Institute of Brooklyn.

Allen Butler Rowley (1908–1961), district sales manager, Chicago Division, Struthers Wells Corporation, Chicago, Ill., died May 29, 1961. Mem. ASME, 1948.

John W. Solomon (1907–1961), vice-president—production, Coty Perfume Co., New York, N. Y., died, May, 1961. Mem. ASME, 1945.

Lucian Charles Sprague (1885–1960), president, The Minneapolis & St. Louis Railway Co., Minneapolis, Minn., died Aug. 3, 1960. Mem. ASME, 1940.

Thomas Jefferson Starke (1895–1961), president, Steel Service, Inc., Richmond, Va., died Feb. 15, 1961. Mem. ASME, 1940.

Gideon Studley, Jr. (1886–1961), retired, steam engineer, Westinghouse Electric Corporation, Summit, N. J., died May 6, 1961. Assoc-Mem. ASME, 1918; Mem. ASME, 1922.

Thomas Nehle Thomas (1912–1961), died May 19, 1961. He was employed

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POSITION TITLE NATURE OF WORK DONE
e.g., Design Engineer, Supt. of Construction, Manager in Charge of Sales, etc

NAME OF EMPLOYER (Give name in full) Division, if any

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PROFESSIONAL DIVISION INTEREST

As a member of ASME, you are entitled to register your interest in THREE (3) Professional Divisions. Place a 1 in the space opposite the Division of your **first** choice, a 2 for your **second** choice, and a 3 for your **third** choice.

01—A Aviation
02—B Applied Mechanics
03—C Management
04—D Materials Handling
05—E Oil & Gas Power
06—F Fuels
07—G Safety
08—H Hydraulic
09—I Human Factors Group
10—J Metals Engineering
11—K Heat Transfer
12—L Process Industries
13—M Production Engineering
14—N Machine Design
15—O Lubrication
16—P Petroleum
17—Q Nuclear Engineering
18—R Railroad
19—S Power
20—T Textile Engineering
21—U Maintenance & Plant Engineering
22—V Gas Turbine Power
23—W Wood Industries
24—Y Rubber & Plastics
25—Z Automatic Controls
26—X Underwater Technology Group

by International Staple and Machine Co. of Herrin, Ill., in the capacity of their international executive vice-president of International Staple et Machine di Fribourg, Suisse, S.A. Assoc. Mem. ASME, 1945.

Earle Walter Vinnedge (1893–1959?), retired, district sales manager, Worthington Corp., Cincinnati, Ohio, died two years ago according to a notice received by the Society. Assoc-Mem. ASME, 1917; Mem. ASME, 1926.

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC [Agency]

These items are listings of the Engineering Societies Personnel Service, Inc. This Service, which co-operates with the national societies of Civil, Electrical, Mechanical, and Mining, Metallurgical and Petroleum Engineers, is available to all engineers, members or nonmembers, and is run on a nonprofit basis.

If you are interested in any of these listings, and are not registered, you may apply by letter or résumé and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee. Upon receipt of your application a copy of our placement-fee agreement, which you agree to sign and return immediately, will be mailed to you by our office. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application.

NEW YORK	CHICAGO	SAN FRANCISCO
8 West 40 St.	29 East Madison St.	57 Post St.

Men Available[1]

Chicago Office

Senior Project Engineer, BSME; 31; ten years' experience in heavy and medium machine design, research, and development, new product development. Some supervisory experience. Highly skilled in stress analysis and mathematical analysis of machinery. $10,000. Chicago area. Me-2249-Chicago.

Research or Development Engineer, graduate mechanical and chemical engineer; 55; experienced in design and selection of process equipment. Familiar with all functions in operation of small companies. Strong technical background. Open. Location immaterial. Me-2250-Chicago.

Project Engineer, BME; 31; six years' experience in design of crawler-mounted rotary blast-hole drills. Project experience includes initial planning through layout and development, prototype erection, and field testing. One year's refinery maintenance experience. Taught engineering subjects at extension center of major university. $9000. Location immaterial. Me-2251-Chicago.

New York Office

Chief Engineer, or equivalent, BSME, 13 years' experience in metalworking field on pressure vessels and piping expansion-joint design including development of cryogenic equipment. Additional background in field of mechanical-engineering instruction. $14,000. Location immaterial. Me-976.

Systems and Procedures Manager, BME, MSIE; three years' experience as management consultant and two years' experience in electronic manufacturing as systems analyst and administrative engineer. Familiar with design and installation of systems for production, inventory, and labor controls as well as office procedures. Me-977.

Project Engineer, Design or Development, MME; four and a half years' custom design experience in heating, ventilating, and air conditioning; selecting and specifying associated equipment. PE in New York. $10,500. Prefers Northeast. Me-978.

Engineering Manager, BSME; 21 years' broad experience in engineering and business management in consumer, industrial, and defense industries; primary characteristics: Creativeness, analytical ability, and breadth of interests. $17,000. Prefers Northeast. Me-979.

Project Engineer, BSME and MSME; six years' experience as an experimental engineer developing high-speed rotating machinery. Duties included co-ordination and supervision of projects through design, fabrication, and test. Projects included the development of pumps, turbines, bearings, and seals. $11,000. Prefers East. Me-980.

Engineer, BS working for LLB; wants to combine administrative and legal training. One year establishing and administering multimillion dollar production contract (electronic equipment). Heavy in cost estimating and negotiations. Another year in production engineering and two years mechanical design of a major electronic system. Open. Prefers West Coast but will consider any location. Me-981.

Production-Control Manager, BME; 36; 13 years' metalworking industries experience, all phases of manufacturing and production management; planning, scheduling, inventory control, shipping, receiving, purchasing, plant arrangement, material flow, contract management policies, procedures. $12,000. Location immaterial. Me-982.

Project or Assistant Chief Engineer, BME; 11 years' experience on varied product design and manufacturing engineering with supervisory responsibility; acted as chief engineer on one job. $11,000. Prefers Conn. Me-983.

San Francisco Office

Project Engineer, Aircraft, ME; 37; seven years' supervisory experience in aircraft responsible for planning, budgets, schedules, engine tests, computer study, analysis, design controls; four years' supervisory experience in marine industry. $20,000. Location immaterial. Present location, Ariz. Se-212.

Project Engineer, Staff, Process Plant, MSME; 43; ten years' equipment and machinery experience for continuous production, possibly metals, design, project development, process analysis, project planning and co-ordination, cost estimates, appropriation requests. $12,000. Prefers San Francisco Bay area. Se-1120.

Sales Engineer, Heavy Equipment, ME; 38; 12 years design and sales of conveyers and power-transmission equipment, sales and sales management experience in volume pressure vessels, tanks, heat exchange, process equipment, hydroelectric equipment. $13,500. Prefers San Francisco Bay area. Se-1060.

Project, Plant Engineer, Construction, Chemical, ME; 35; 12 years' varied engineering experience in chemical plant, refinery, and construction. Project (mechanical) design, planning, development. Construction co-ordination and quality control. $11,000. Prefers San Francisco or Denver. Present location, Ark. Se-365.

Staff Engineer, Steel Cast-Iron Products, ME; 40; 15 years' experience designing many items of equipment and structures and supervised their construction and installation (turbine boilers, layout manufacturing plants, cast iron, manganese ore-treating plant). In all positions held has been in charge or first assistant. $10,000. Prefers West Coast or Pacific Far East. Present location, Manila. Se-1791.

Research and Development Engineer, Nuclear or Heat Power, MSME, Germany; 29; four years' experience design of steam-generating equipment. Research related to heat transfer, fluid mechanics. Office organization. Technical reports, papers. Supervisory level. $10,000. Prefers West Coast. Present location, Mass. Se-1342.

Power-Plant Engineer, Utility, or Consulting, ME; 40; 14 years' experience as design engineer, research and development, staff department head, nuclear training (ORSORT); professional mechanical engineer. $15,000. Prefers Midwest or West. Present location, Minn. Se-1246.

Management Engineer, Construction, Process Industry; 43; nine years in charge of plant design, construction maintenance; 11 years chief electrical engineer and consultant. Supervised mechanical, electrical, structural engineering, estimating and planning. Sold engineering and construction services. $18,000. Prefers San Francisco Bay area. Se-1595.

Plant, Project, Field Engineer, Chemical, Petroleum; 43; five years' experience supervising plant-engineering activities for chemical plant; five years liaison for design office, interpret plans and specifications for contractors for architectural engineering office; two years public-utility work, supervision of installation of boilers, turbogenerator. $13,000. Location immaterial. Present location, Okla. Se-340.

Sales Engineer, Heavy Industrial and Power Apparatus, ME, Economics; 35; five years' Bay area sales experience with national manufacturer of heavy industrial air conditioning, power plant, and power transmission. $10,800. Prefers San Francisco Bay area. Se-1808.

Mechanical Engineer, Manufacturing, ME England; 40; 15 years' foreign and U. S. experience in development of special purpose machines used in manufacturing of porcelain components design through installation; design of mechanical and electromechanical, instrumentation, for use in radio and television. $9600. Prefers San Francisco area. Se-127.

Designer, Mechanical Equipment, ME; 27; recent graduate with 16 months' experience in design of mechanical services of buildings, power stations (diesel) and boiler rooms, erection of overhead traveling cranes, foundry furnaces, hydraulic presses. Open. Prefer San Francisco area. Se-498

Positions Available

Chicago Office

Director, Research and Engineering, PhD or MS, or mechanical engineering or physics, 32–45, experienced in fluid-flow mechanics, mechanical instruments; knowledge of physics, systems engineering, hydrodynamics. Basic and applied research activity in fluid-measurement field and development of advanced designs of meter. Research and development of systems and instrumentation for indicating, recording, and telemetering of flow data for a meter manufacturer. $10,000–$13,000. Employer will pay fee. Southern Wis. C-8782.

Power-Plant Designer, graduate mechanical, to 40, several years' experience in steam-generating plant design or utility experience, to assume responsibility of a small design group. In addition to generating-plant design will assist in certain phases of engineering reports on feasibility of generating plants, including preparation of construction-cost estimates and operating costs, make property inspection of utility clients, render help to clients in plant operation and betterment. Ability to assume technical and executive responsibility and to represent company at board meetings and client conferences. Must be U. S. citizen. $8000–$10,000. Employer will negotiate fee. Neb. C-8776 (*a*).

R & D Engineer, graduate mechanical, for research and development on heat-transfer equipment and instrumentation; no military assignments; permanent position with a manufacturer of heating and cooling systems. To $10,000, depending upon experience. Employer will negotiate fee. Forty miles northwest of Chicago. C-8773.

Teaching Personnel, BS or better, at least three years' experience in industry augmented by some teaching work. (*a*) Mechanical engineer to teach machine design. (*b*) Industrial engineer to act as head of IE Department. $5600–$9600 based on nine months, depending on experience; good opportunity in relatively new and growing school with an enrollment of 1200 engineering students. Southern Calif. C-8771.

Sales Engineer, graduate mechanical, industrial, or general engineering, at least two years' experience in machinery sales, to contact food and beverage manufacturers, to sell packaging and bottling machinery. Will work under direction of regional manager. Travel about 40 per cent of time through Ill., Ind., and Mich. Car required. $8000–$10,000, depending upon experience. Employer will pay fee. Chicago. C-8762.

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[1] All men listed hold some form of ASME membership.

Engineers (*b*) Development engineer, plastics, graduate mechanical, 30–40, to develop machinery for plastic molding on bottles and containers. Ability to put machinery into operational uses. Knowledge of polyethylene essential. $12,000–$15,000. Employer will pay fee. (*c*) Plant manager, graduate mechanical preferred, to be responsible for entire plant operations of company engaged in light sheet-metal fabrication such as store shelving; must be energetic and have demonstrated supervisory ability; knowledge of material handling helpful; company employs about 75. $12,000, plus stock option. Company will pay fee. Pa. C-8757.

Senior Thermal Executive Engineer, graduate mechanical, 40–45. Under direction of general manager, will direct assigned projects, delegate technical aspects of client contact to department heads, submit monthly reports on projects including statement of progress, expenditures, and estimated income, secure from chief engineer best available project engineer and make arrangements for assignment to the project group of personnel needed; prepare budgets and schedules, sign drawings and specifications, forecast manpower for assigned projects. Company engaged in design of hydroelectric, thermal pulp and paper projects throughout Canada and overseas. Also some industrial projects. $13,000–$15,000. Canada. C-8747.

Design and Development Engineers, mechanical, to 60, at least three years' experience in design and development of electromechanical hydraulic and electrical components. Assist in preparation of technical proposals; design, develop, and test equipment to customer's specifications. Work as liaison with customers engineering departments. Experience in servomechanisms desirable. About $10,000. Company will negotiate fee. Calif. C-8744.

Production Administrator, graduate engineer, to 40, thoroughly familiar with machine-shop operations, assembly and servicing of such equipment as pipe mills, slitters, coil-handling equipment, forming mills, etc. Must have proved record of success in manufacturing management. Will work with top management handling all manufacturing at several plants. Unusual potential, for a manufacturer of heavy equipment. Open. Employer will pay fee. Midwest. C-8740 (*a*).

New York Office

Manufacturing Manager, mechanical-engineering education and experience, emphasis on structural-steel fabrication; must be knowledgeable in industrial-engineering procedures. Will be responsible to direct and supervise production of components of material-handling systems and machinery such as idlers, vibrating conveyers, feeders, screens, etc. Will supervise about 300 employees. From $12,000, plus participation in corporate profit-sharing plan; all fringe benefits. East. W-687.

Assistant Editor, mechanical graduate, five to ten years' technical magazine publishing experience in heating and air-conditioning fields. Open. New York, N. Y. W-684.

Manager of Research, MS or better in mechanical engineering, at least five years' administrative and supervisory research experience covering heat transfer, processing, and air-conditioning equipment. Open. New York, N. Y. W-683.

Instrumentation Engineer, mechanical or chemical graduate, experience which includes the design and specifications of complete control systems for chemical and process plants. Systems are mainly pneumatic. Electronic-controls experience desirable but not necessary. $8000–$13,000. Eastern Pa. W-681 (*b*).

Budget Director, mechanical-engineering or business-school graduate, ten to 20 years' budget cost, estimating, manufacturing, and sales coordinating experience in automatic and special machinery fields. Must have considerable knowledge of various types of dies. $20,000 range. Midwest. W-679.

Development Group Leader, mechanical or chemical-engineering graduate, at least five years' equipment design and development experience covering compression, cooling, and transportation of gases and liquids. To $12,000. Company pays fee. N. J. metropolitan area. W-676.

Project Engineer, mechanical graduate, plant-engineering experience in food-processing fields to supervise installation and start-up of liquid processing and filling equipment. $8000–$10,000. Md. W-670.

Engineers. (*a*) Mechanical or aeronautical engineering, or applied mechanics, MS degree, three to ten years' experience, aeronautical-structural design and electromechanical experience. Will be in charge of R&D project. $7200–$12,000. (*b*) Mechanical or electrical engineer, BS degree, three to seven years' experience in electromechanical engineering, for R&D engineering. Will be involved in systems engineering and would contribute to the design and analysis of such areas as lighting, ventilation, signals and controls, door actuators, etc. $7200–$10,800. Pa. W-668.

Additional listings of positions and men available are maintained in the offices of E.S.P.S. Direct inquiries to nearest office. A weekly bulletin of engineering positions open is available at a subscription rate of $4.50 per quarter or $14 per annum, payable in advance.

Engineers. (*a*) Project manager, ovens, to supervise sales and application activities of oven equipment. Experience in the application, design and/or fabrication of industrial-oven equipment. $10,000–$15,000. (*b*) Sales Coordinator, mechanical or electrical graduate, some sales related experience. Should be free to travel or relocate as will be promoted to sales engineer after comprehensive training period at main office. $6500–$7500. Company negotiates fees. Wis. W-667.

Appraisal Engineer, graduate mechanical, ten to 15 years' experience in engineering and construction, including cost estimating, minimum of five years' experience in appraisal office and field work required. Must hold a PE license. Some travel involved. Apply by letter including salary requirements. Mass. W-663.

Gage-Design Engineer, BS or MS in mechanical or electrical engineering, five to ten years' experience in gage and/or instrument design. Training and experience in both electrical and mechanical design would be especially desirable. $10,000–$14,000. Company pays placement fee and moving expenses. Conn. W-657 (*a*).

Engineers. (*a*) Manager, advanced engineering section; BS or MS in mechanical engineering, 15 to 20 years' experience in the design and development of automated machine tools or related industry. (*b*) Manager, planning and measurements section, BS or MS in mechanical or electrical engineering, 12 to 20 years' experience in the machine tool or related industry. Possess the ability to recognize problems quickly and take corrective action without prompting. Company pays fees and moving expenses. $16,000–$23,000. Conn. W-656.

Engineers. (*a*) Research or product-development engineer, BSME or educational equivalent. Five to eight years' experience in the electromechanical field with majority in consumer products. Must be able to plan methods for solution of technical problems and devise means of testing and analyzing results. $9000–$12,000. (*b*) Research or product-development Engineering Trainee, BSME, little or no experience, strong desire and aptitude for the electromechanical field. $6500–$7500. (*c*) Design engineer, engineering degree or substantial experience electromechanical products. Will prepare master layouts of new and redesigned products and assist drafting department in preparation of production drawings. Must have knowledge of mechanics, materials, and processes. $6500–$8000. Conn. W-653.

Mechanical-Design Engineer, BS or MS in mechanical engineering, ten to 15 years' experience in machine-tool design or related industry. Must be able to accept full project responsibility and provide technical direction to draftsmen and laboratory technicians. $12,000–$16,000. Company pays placement fee and moving expenses. Conn. W-646 (*a*).

Pulp and Paper-Mill Engineer, degree in mechanical, chemical, or industrial engineering, and qualified to obtain PE licenses; ten years' experience in paper mill, either in operations, engineering, or consulting. Position will require participation in new business contacts, development of proposals, feasibility reports, market surveys and estimates for pulp and paper mills, direction of engineering and design. Open. Apply by letter including salary requirement. Mass. W-625.

Assistant Chief Engineer, Pulp and Paper Division, graduate eight to ten years' direct experience in the design of pulp-processing machinery. Will be responsible for the design and development of pulp and paper machinery. $8000–$10,000. Canada. F-614.

Editor, mechanical or electrical, trade publication, to plan, develop, and produce editorial material in the field of energy-systems engineering. Experience in steam generation and/or instrumentation and control preferred. Some travel. $10,000. New York, N. Y. W-608.

San Francisco Office

Plant Engineer, graduate mechanical or chemical, to 45, five to ten years' experience in chemical-process industry, schedule, and control maintenance programs (standardization, preventive, safety); design and specify utility-equipment systems; assist in expansion; on new and existing plant. For a chemical-process corporation (fermentation and biologies). To $11,000. Southern Calif. Sj-6390.

Designers, Hydraulic Systems, BSME or MS, to 50, solid, recent, top level, technical experience related to the use and applications of hydraulic or pneumatic pumps, motors, valves, piping, in over-all complex systems to satisfy clients needs; familiar with servo applications and other related control or actuator hydraulic components. For a manufacturer, fabricator, and installer of automated equipment. $12,000, up. San Francisco East Bay. Sj-6257.

Designer, Actuators, mechanical engineer, to 35, three to ten years' experience, relating to release or actuating mechanisms (electromechanical, hydraulic, pneumatic) operated mechanically, spring release, or explosive release of special umbilical electrical connectors. Able to design to performance specifications, assist in design proposals, provide liaison with client, supervise product development into production; a design task for aircraft or missiles components. Growing, small, young subsidiary manufacturing company. $10,000. Southern Calif. Sj-6369.

Designer, Accelerators, graduate mechanical required, minimum of five years sophisticated mechanical-instrument design related to cyclotron, components, test equipment. U. S. citizenship required, security clearance. For a consultant. About $9600. San Francisco East Bay. Sj-6343.

Research, Development, Design Engineers, Jet Propulsion, Space, BS, MS, PhD in civil, mechanical, electrical, chemical, math., physics, one to ten years' experience related to space-flight equipage, operation investigation; celestial mechanics, inertial guidance, electrical cabling, telecom, controls, communications, systems, components, circuitry, computers, power, analysis, performance, flight, ground, reliability, servos, transistors, solid state, electro-optics, pyro, structures, vibration, gas, fluid, heat, stress, strain, motors, numbers, solutions, aerodynamics, concepts, feasibility, propellants, polymers, semiconductors, viscoelastics, fuels, liquid metals. For a research lab. Southern Calif. Sj-6373.

Production Engineer, Industrial Doors, graduate mechanical, to 45, minimum of three years' metalworking experience. Will handle plant layout, design new machines, methods, product design in plant manufacturing light structural and sheet-steel components (machine shop, metal forming, steel fabricating, finishing). $6900–$7200. San Francisco. Sj-6358.

Sales Engineer, Instruments, 23–35; three months training course; will sell temperature, pressure, flow, liquid-level-type of instruments for measurement and control to process industry, process equipment, and contractors (pulp, paper mills, petrochemical, food processing and preserving, sugar and rubber, air conditioning, milk products). $6300–$6900, plus expenses. San Francisco Bay area. Sj-6362.

Inspector, Ventilating, Air Conditioning, graduate mechanical, minimum of five years' experience, to inspect mechanical aspects of heating, piping, ventilating, air conditioning, water lines on new construction project. Job will last about two years. $9600. Calif. Sj-6072.

Designer, Can Machine, mechanical, 30–40 experienced in machine design and possibly plant maintenance and organization, related to specialty tin can manufacture (slit, notch, form, fold, spin, bead, edge). Short runs moderate speed. Able to accept full responsibility for design to operation in small plant for machine design of modification, to be built by outside firm, to supervise maintenance and technically assist in production. $7800–$10,200. San Francisco Peninsula. Sj-6360.

Sales Engineer, Mine, Mill, graduate mechanical, mining, or metallurgical, to 32, two years' experience in process plant as assistant superintendent or foreman; on clarifying, ball mills, dry or wet process. Train one or two years in eastern plant; return to San Francisco, cover Pacific Coast, Ariz., and Nev. Position with a manufacturer of heavy mill-type machinery. $7200. Sj-6389.

Industrial Engineer, Food Processing, IE degree preferred, young; recent graduate to a few years' experience in industrial engineering, to deal with problems of process-time study, to establish standard cost of process and operations. $6180. San Francisco area. Sj-6382.

YARWAY news briefs

from **Yarnall-Waring Company,** *Philadelphia 18, Pa.*
BRANCH OFFICES IN 19 UNITED STATES CITIES • SALES REPRESENTATIVES THROUGHOUT THE WORLD

IF DEPENDABILITY IS WHAT YOU WANT... GET UNIT TANDEM BLOW-OFF VALVES

New Yarway Unit Tandem Blow-Off Valves for boiler pressures to 515 lbs. wsp* "have what it takes" to give you the dependable protection your boiler investment deserves.

RUGGED, COMPACT DESIGN

Unique design and strong construction combines blowing and sealing valves in a common "unit" body of forged steel block—extra *protection*, extra *dependability*.

DEPENDABLE PERFORMANCE

Design, materials, workmanship add up to *trouble-free performance*. Seatless (sealing) valves are famous Yarway balanced sliding plunger type. Hard-seat (blowing) valves are Yarway welded-bonnet type, with deep stellite seat and disc, non-pitting stainless steel valve stem and special inhibited packing.

EASY MAINTENANCE

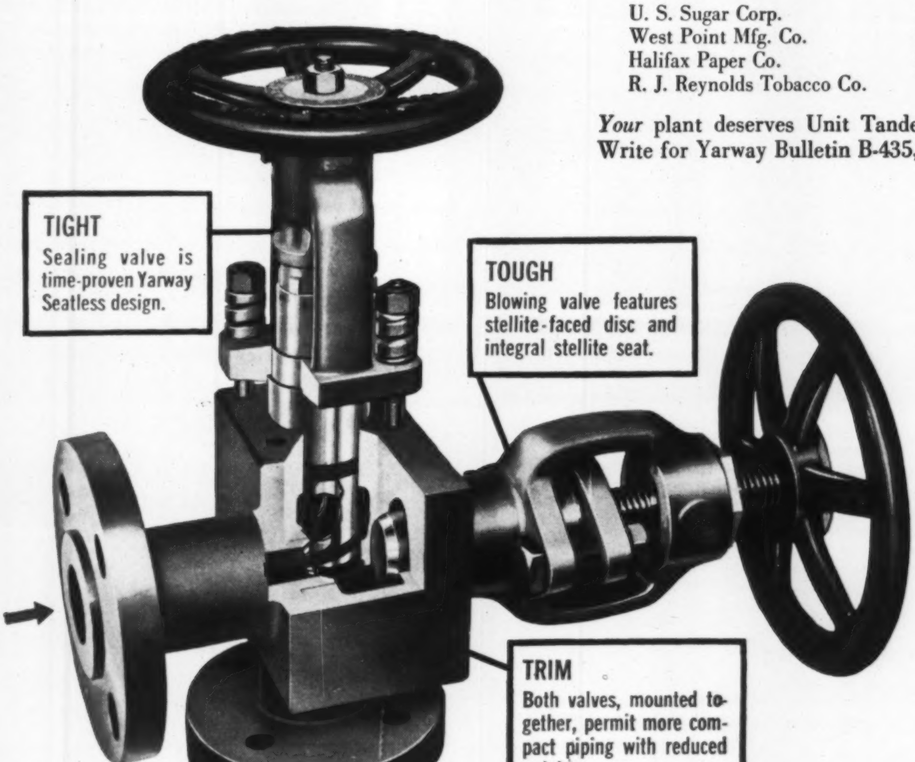
Working parts are easily accessible. Special reseating tool permits actual reseating of hard-seat valve with *valve in the line.*

PROVED ACCEPTANCE

Among hundreds, here are just a few satisfied users of this Yarway valve:

- U. S. Sugar Corp.
- West Point Mfg. Co.
- Halifax Paper Co.
- R. J. Reynolds Tobacco Co.
- Western Electric Co.
- Cornell University
- Pulp and Paper Co. of Colombia, S.A.

Your plant deserves Unit Tandem dependability, too. Write for Yarway Bulletin B-435, Supplement A.



TIGHT
Sealing valve is time-proven Yarway Seatless design.

TOUGH
Blowing valve features stellite-faced disc and integral stellite seat.

TRIM
Both valves, mounted together, permit more compact piping with reduced weight.

*Yarway Unit Tandem Valves are also available for higher pressures to 3206 psi.

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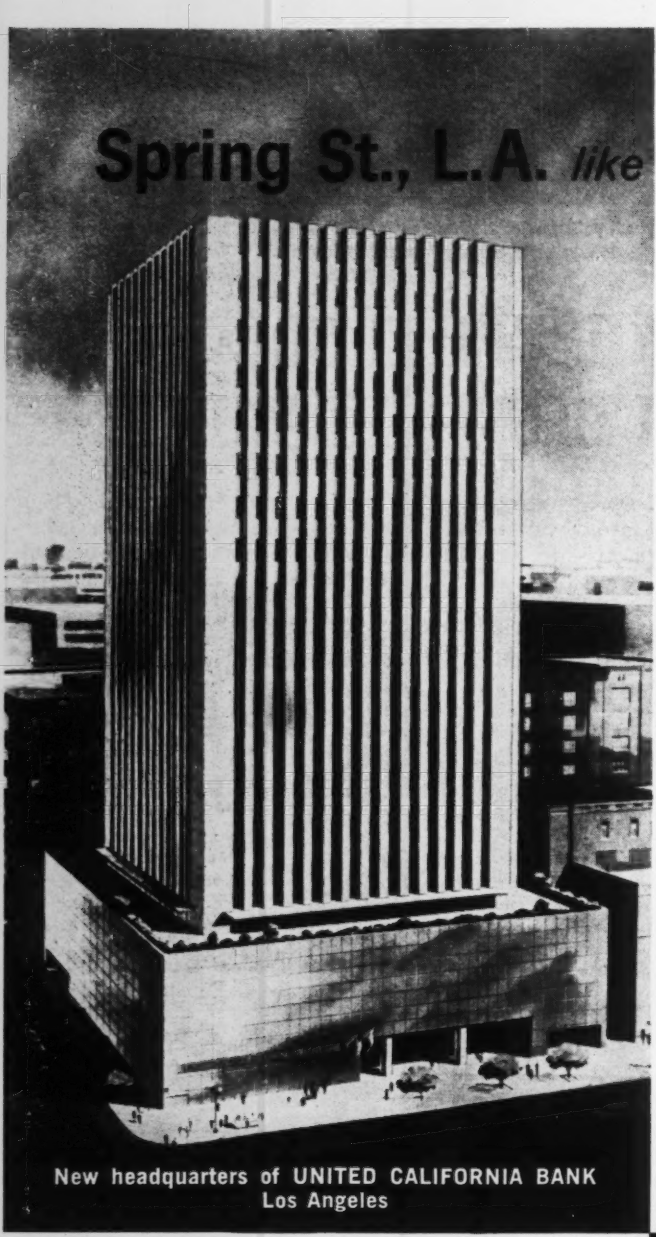

Spring St., L.A. *like* Wall St., N.Y.C.

knows the soundest investment in valves

Again, JENKINS VALVES are the bankers' choice

New headquarters of UNITED CALIFORNIA BANK
Los Angeles

Taller, perhaps, but there's no *finer* bank building in New York than the new Head Office of United California Bank on Spring Street in Los Angeles' financial area. Headquarters for 122 offices in California, this 370,000 sq. ft. building is an outstanding example of the excitingly modern architecture and superb engineering and construction which draws many building experts to Southern California for a "look-see."

There's an expected "California difference" in the design and decor of this bank. But a significant fact is that, like so many of the great bank buildings in New York and other cities, the valves that control the piping systems bear the same *"Diamond and Signature"* trademark.

Obviously, California bankers and their architects and engineers agree with their contemporaries everywhere about the soundest investment in valves. To assure a building-lifetime of trouble-free, economical valve service, they call for JENKINS.

Why should *you* settle for less . . . especially when Jenkins Valves *cost no more* than other good valves? Specify "Jenkins Valves," for almost a century *the standard of quality*. Jenkins Bros., 100 Park Avenue, New York 17, N. Y.

Architect: Claud Beelman & Associates; *Mechanical Engineer:* John C. Freeman; *Mechanical Contractor:* Mehring & Hanson Co.; *General Contractor:* C. L. Peck Construction and Realty Co. . . . all of Los Angeles

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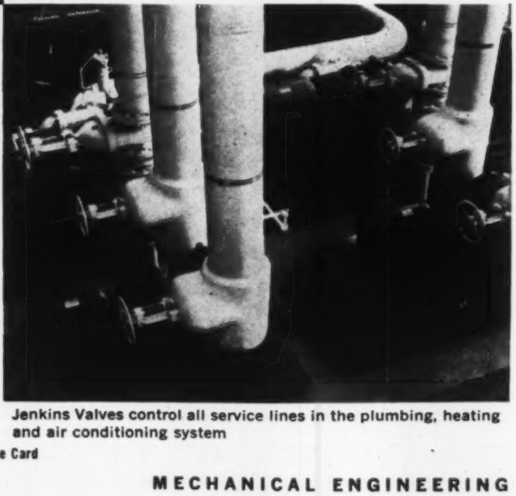

Jenkins Valves control all service lines in the plumbing, heating and air conditioning system

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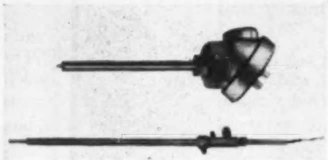
Available literature or information may be secured by using convenient Readers Service Card on Page 129

NEW EQUIPMENT



High-Temperature Thermocouples

A line of thermocouples designed to measure temperatures up to 4000F and even higher has been developed by Aero Research Instrument Co. These are of cooled and noncooled types to measure liquid, solid, and gaseous temperatures.

The applicability of these temperature sensors is accomplished by the use of refractory metals, that is, tantalum and molybdenum with special CR oxidation-resistant coatings. Insulation is magnesia and beryllia, and thermocouple wires are iridium, tungsten, rhenium, and alloys of these elements.

These probes are designed for such typical applications as measuring the temperatures of exhaust gas in an afterburner, molten glass, fuel pins of a nuclear reactor, missile nose cone, combustion processes, flue gas (checkers, also), crystal-growing ovens, and many others. **—K-1**

Motor, Pump, Tank Units

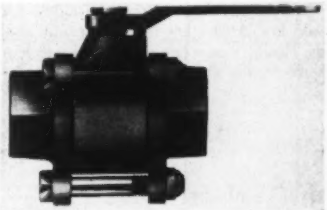
Wisconsin Hydraulics announces the introduction of a line of motor, pump, tank units (MPT). This is an addition to the regular line of Lectrolifts, which have been on the market for sometime as a d-c motor, with pump, reservoir, and three or four-way valves.

The MPT line now uses a-c motors in fractional and integral horsepower sizes directly connected to a reservoir tank in a wide choice of sizes. Pumps are mounted inside the tanks to provide a complete range of pump capacities and pressure requirements. Control valves for any circuitry design can be mounted directly on to the package to provide a complete hydraulic self-contained power package for all applications. **—K-2**

Speed Reducer

A fractional horsepower speed reducer, smallest in the Torque-Arm line, is being introduced by Dodge Mfg. Corp. The new unit, identified as TD025, has a gear ratio of 25 to 1 and will transmit up to 0.95 hp at maximum recommended output speed of 85 rpm. A predetermined combination of reducer and V-belt drive can provide any speed ratio up to 175 to 1.

As a shaft-mounted reducer it is equipped with a torque arm for simple adjustment of V-belt drive center distance. Overload release is optional. As a flange-mounted reducer, it can be bolted directly to the driven machine or supporting structure. Standard TD025 reducers are bored for mounting on $1\frac{1}{4}$-in. shafts, and bushings can be furnished to adapt for smaller shafts. Special TD025 bored for $1\frac{3}{16}$-in. shafts is also available. **—K-3**



Plug Valves

Industrial users seeking a valve with a straight-through flow equal to schedule 40 pipe will be interested in the compact ball-type valve now being produced by Pittsburgh Brass Mfg. Co.

Called the spherical plug valve because of its ball-type design, the company states that this model offers valve users four major advantages: The fullest possible flow, with none of the commonly found restrictions that set up pressures causing ordinary valves to leak; quick opening—actually an easy quarter-turn opens or closes this valve, a desirable feature when many valves are to be operated in a minimum time; the lowest of silhouettes, permitting installation in pipelines denied others and, additionally, an operating handle that can readily be revolved to a more convenient position if required; and important savings in maintenance assured because the valve is of the nonlubricated type, the externally adjustable seats are of Teflon, the synthetic with a "feel" and excellent resistance to heat. This material makes possible a self-wiping action that eliminates scoring and galling. Additionally, the valve can be serviced, if necessary, by simply unloosening body bolts and lifting out the center section. **—K-4**

Drafting Machine

A compact, desk and table-top drafting machine which makes it possible to provide accurate finished drawings of complex diagrams rapidly, was introduced by Keuffel and Esser Co.

Called the "Paragon Jr.," the new unit is for use by the design engineer, architect or draftsman who requires a board for part-time office or home use; the student of drafting (for classroom use) and others who have only an occasional need for a drafting board.

Combining the drawing capabilities of a T-square, straightedge, triangle, scale and protractor, the Paragon Jr. features controls that permit one-hand operation. This minimizes the number of arm and hand motions needed to produce the finished drawing. A simple bracket assembly facilitates temporary or permanent mounting on almost any desk, board or table. **—K-5**

Filtering Equipment

The science of obtaining maximum production in machining and grinding operations while simultaneously paring costs has rereceived fresh impetus with the development of the Hoffman Hi-Flo Vacu-Matic filter capable of handling water-soluble oil coolants in quantities from 200 to 2500 gpm. The Hoffman Hi-Flo Vacu-Matic filter is claimed to provide a record 20 to 50 per cent savings in grinding wheels, honing stones, broaches and other edge tools and is a significant forward step in modern metalworking techniques. Basis of development is long experience with 40, 60, 80 and 120-gpm filters. Bulletin FB 107 of Hoffman Industries, Industrial Filtration Div., Inc., gives descriptive information.

The Vacu-Matic is simple in design, virtually trouble-free in operation, and suitable for all grinding and machining operations using water-soluble oil coolants. Operation is entirely electrical and continuous

The use of the Vacu-Matic filter in grinding and machining operations makes it possible to obtain numerous competitive advantages that add up to higher speeds, faster feeds and better finishes. **—K-6**

NEW! *King* COMPRESSED AIR FILTERS

20 to 200 scfm
¼" to 2" NPT

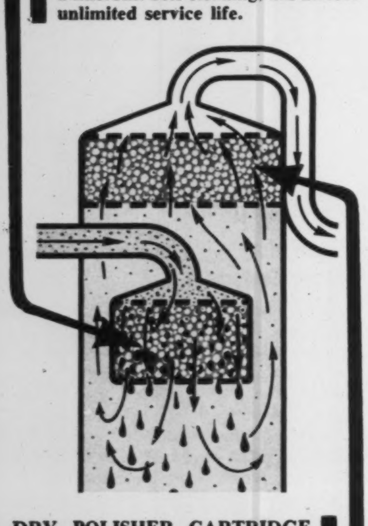
REMOVE ALL HARMFUL TRACES OF DIRT, WATER AND OIL—

Month after Month with

NO MAINTENANCE!

HERE'S HOW:

WET SCRUBBER CARTRIDGE causes mist and fog to form large drops that fall into sump. Takes out dirt, water and oil down to **less than 2 microns.** Self-cleaning; has **almost unlimited service life.**



DRY POLISHER CARTRIDGE removes practically the last remaining traces of dirt, water and oil; leaves the air **exceptionally clean.** Scrubber cartridge does nearly all the work, so Polisher also has **almost unlimited service life.**

Get ALL the facts! Write today for free KING FILTER CATALOG.

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Gate Valves

Plastic-coated resilient-seat gate valves with high resistance to abrasion and corrosion have been introduced by Edward Valves, Inc. Subsidiary of Rockwell Mfg. Co. The steel valves are suitable for chemical, cement and similar process piping where abrasive-corrosive liquids and slurries are handled.

Valve wear is largely confined to the replaceable seat insert and gate. Although these parts are extremely long wearing, they can be replaced easily when necessary while the valve body remains in the line. The valve bonnet lifts off after removing the bonnet nuts, giving access to the removable seat insert and gate. The plastic coating, known as EValcoat, is a special new formulation of phenolic, epoxy, and other resins baked on the internal valve-body surfaces. Field tests show that the coating resists undercutting and peeling even if it is mechanically broken. Noncoated valves are available for applications where corrosion and erosion are not a problem.

Large unrestricted openings from the line into the bonnet cavity eliminate bonnet clogging in slurry service. Flow keeps the bonnet flushed free of loose particles. Enclosed low-pitch stem threads permit quick, easy closing and opening. Impactor handwheels permit tight closing. **—K-7**

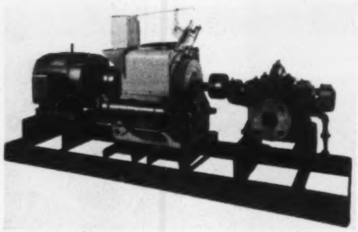
Barrel Tumbling

A vibratory barrel tumbling machine featuring electromagnetic vibratory drives has been introduced by Syntron Co. It can be used for deburring, cleaning, descaling, or other parts-finishing jobs.

Powerful, controlled, directional vibration keeps both parts and media agitated and constantly working 100 per cent of the time. This constant vibration assures more thorough working of hard-to-get-at places and shielded areas. The amplitude of vibration can be instantly varied, while the same frequency of 3600 vibrations per min is maintained. A turn of the rheostat knob on the control box is all that is required to change the amplitude.

These self-contained, compact units are available in three models with 0.4, 1, and 6-cu ft barrel capacities; larger models will be available. They are designed to reduce parts handling, incorporating a screen cover and hose connection for flushing out compounds and a screen trough to separate the parts and media. The same directional vibration that finishes the parts, moves the parts and media across the screen dressing for rapid separation.

The same compounds and media used in other tumbling equipment may also be used in Syntron vibratory barrel tumbling machines. Brochure available. **—K-8**



Pumping Unit

The "Accupressure" system for maintaining constant water pressure within $1^1/_2$ to 2 per cent limit despite varying demand has been developed by Allis-Chalmers engineers.

The system consists of a centrifugal pump (Type S or KS), a constant-speed motor and a fluid drive and control. It is available in 3 to 200-hp range, 50 to 5000 gpm, primarily for use in buildings where large volume and constant pressure are required but where demand varies.

The control consists of a pressure-sensing device which in turn governs depth of a scoop tube on the fluid drive. This action raises or lowers speed of the output shaft to the pump. When applied and adjusted properly, BHP requirements of an Accupressure unit will never exceed that required on the curve at the design point. **—K-9**

Nonmetallic Heating Element

An improved nonmetallic silicon carbide-molybdenum disilicide heating element, known as "Super Hot Rod," has been developed by Norton Co. for use in kilns and furnaces up to 1700 C.

Not only does this new element have longer life at the normal maximum operating temperatures of conventional silicon-carbide heating elements (about 1500 C), but it raises the maximum operating temperatures about 15 per cent without losing its long-life properties. This long life is achieved because of the excellent oxidation resistance of this material.

This new element can be operated up to 1700 C without requiring a protective atmosphere. It also can be used in special atmospheres where the present silicon-carbide elements are being used.

The techniques for installing and operating the Super Hot Rods are the same as those for conventional silicon-carbide elements. However, the new rod can be expected to reduce the cost of rods and rod maintenance because of longer life and greater thermal-shock resistance. Because of higher working temperatures, some heating operations, previously beyond the capacity of conventional bars, may be practically done by this method. **—K-10**

When you specify

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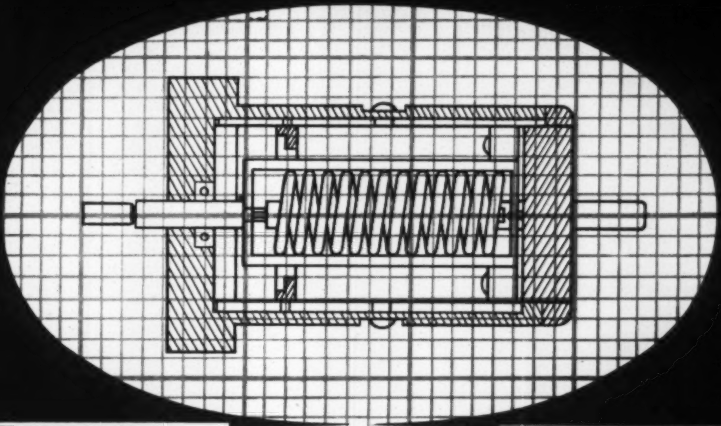

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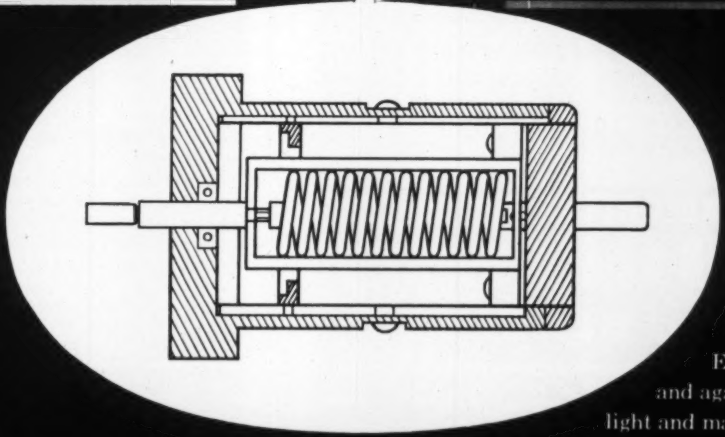

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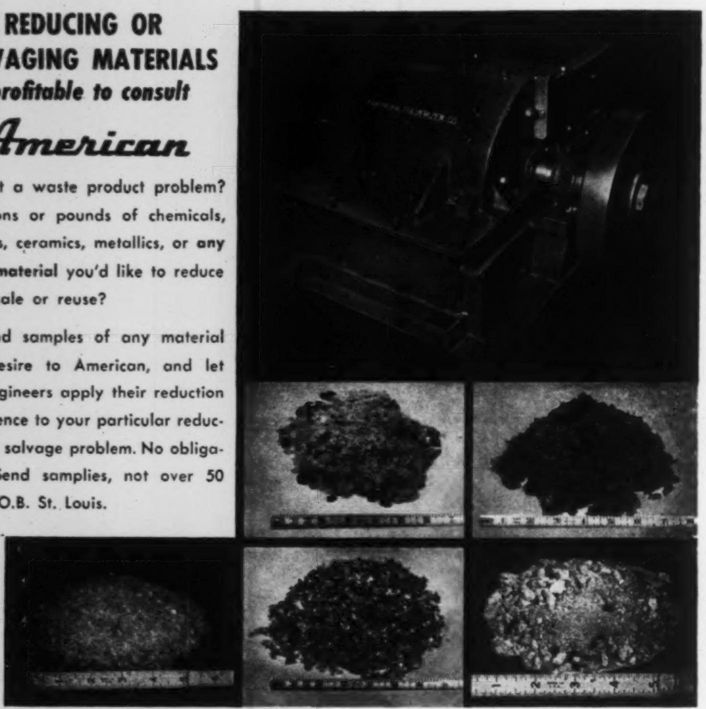
Send samples of any material you desire to American, and let our engineers apply their reduction experience to your particular reduction or salvage problem. No obligation. Send samplies, not over 50 lbs., F.O.B. St. Louis.



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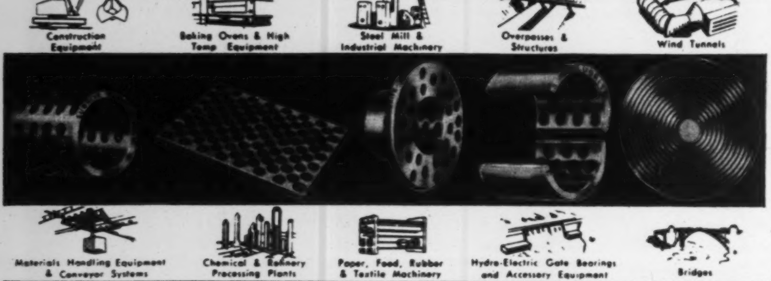
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Plastic-Lined Valve

A valve, designed especially to combat destructive effects when controlling the flow of corrosive fluids, has been announced by William Powell Co. in a data sheet. It is a metal, plastic-lined Y-type valve; metal for safety, strength and long life; plastic lining to assure purity of end product.

While these valves usually are cast carbon steel, they can be supplied in other alloys on special order. They are presently made in sizes from 1 through 3 in., with dimensions conforming to ASA Standard B16.5 for 150 psi. **—K-11**

Tapping Screw Chart

A value-analysis chart for tapping screws, designed as an aid for tapping-screw evaluation in inspection and production departments, is available from Parker-Kalon, a div. of General American Transportation Corp. The chart may be used also to set up assembly performance criteria.

Complete information is given on the various features of tapping screws with respect to their performance on an assembly line; concentricity of head, accuracy of slot, position and depth of Phillips recess, thread formation, and screw hardness and functionability. This is done by illustrating what to look for, how to check and with what instruments, and why these features are important in terms of cost and efficiency. **—K-12**

Gas-Oil Burner

Webster Engineering Div. of Midland-Ross Corp. has introduced completely redesigned and improved models of the Webster "Cyclonetic" burner. Designated as the Model J Cyclonetic, the two sizes immediately available offer input ranges from 700 to 2250 mbtu per hr and 1400 to 4200 mbtu per hr respectively. Both models are offered as single or dual-fuel burners for any fuel gas or No. 2 fuel oil, arranged for either pedestal or suspended flange mounting.

The Model J Cyclonetic is a factory assembled, wired and tested package incorporating a unique combustion-head design which assures positive flame retention for quite, stable combustion. Suitable for positive or negative furnace pressures in any type of boiler or furnace, optimum efficiency is achieved with low motor horsepower on both gas and oil operation.

The standard burner package includes an indicating program timer to sequence the blower motor, flame-rectification combustion safeguard and motorized gas valve or solenoid oil valves. The system provides for complete purge prior to pilot ignition and after normal operation, as well as insuring a complete purge cycle following automatic fuel transfer or interruption of normal operation for any reason. **—K-13**

Stored Energy Package

Announcement of the Con-O-Pak, a unitized fast acting stored energy package to actuate a wide range of mechanisms, has been made by the Conax Corp.

This small, light weight, compact Con-O-Pak releases high pressure gas from the storage bottle by an explosive actuated pressure release valve which operates in only 0.002 sec at recommended firing current of 2 amp.

The minimum firing current required to operate this explosive actuated valve is only the amperes from a power source as low as $1^1/_2$ volt. A few of the many Con-O-Pak applications include its use as a stored power source for safety and fire extinguishing systems, control valves, pneumatic actuators, pressurizing and purging systems and many others.

Its design permits Con-O-Pak to operate in explosive atmospheres with safety. Operating temperatures range is from −65 to −160 F.

The standard gaseous charge is nitrogen at 350, 500, 1000, or 1500 psi. Other gases are available including helium and carbon dioxide. Standard Con-O-Pak is $6^1/_2$ in. overall length, holds 3 cu in. of gas and weighs only $5^1/_2$ oz. A wide range of cylinder sizes and capacities are also available.

The standard explosive actuated pressure release valve is machined from 2024-T4 aluminum and anodized. Storage bottle is made of Type 1010 steel. Other materials may be used for compatibility of gases and atmospheric conditions. **—K-14**

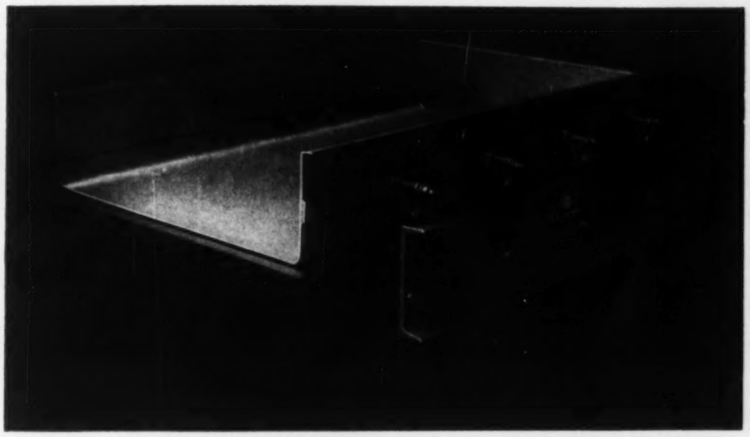
Piston Motors and Pumps

Fixed displacement axial type piston motors and pumps of four different capacities are now in production at Webster Electric Co. Developed especially for the industrial machine field, the pumps, called the C3F series, will have displacements of 0.72, 1.09, 1.45 and 1.81 cu in. per rev.

The new units, rated for continuous duty of 3000 psi and intermittent pressures to 3500 psi, produce capacities from 3.3 to 8.5 gpm at 1200 rpm, and 5 to 14 gpm at 1800 rpm. Operating speeds are up to 2400 rpm and the largest unit can deliver 18 gpm at this speed.

Used as motors, these four sizes have theoretical torque ranges of 11.52, 17.28, 23.04 and 28.80 in.-lb per 100 psi, or output horsepowers (1200 rpm) ranging from 5.5 to 14 and (at 1800 rpm) from 8 to 22, operating at 3000 psi. The largest size operating at 2400 rpm can deliver 28 hp at 3000 psi.

The mounting bosses of the new pumps are large enough to handle 1 in. NPT inlet or $1^1/_4$ in. od tubing thread. The side ports may be mounted either horizontally or vertically. Several variations of drive shafts will be available, from straight keyways to splines. **—K-15**



Save Space, Installation and Maintenance Costs with

AJAX VIBRATING FEEDERS

Designed for short carries between machines, conveyors and processes, Ajax Vibrating Feeders combine mechanical simplicity, absence of complicated electrical systems and low cost. They are easy to install as part of a material handling system. They can be designed into complete processing units. 3′ to 10′ lengths, widths from 6″ to 36″. *Write for information.*

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Conveyor Division
AJAX FLEXIBLE COUPLING CO. INC.
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Representatives in Principal Cities

Circle No. 168 on Readers' Service Card

Positioning Device

A new positioning device has been introduced by the Skinner-Horton Chuck Div. of Skinner Precision Industries, Inc. The standard size of this three-jaw, self-centering positioner has a capacity from 3 to 40-in., larger and smaller sizes are available on special order.

The manufacturer describes this as a fast, accurate positioning device for such applications as welding and flame-hardening. Hardened steel jaws open and close at a turn of a wrench and work is automatically centered. The holding device mounts on headstock, turntable, or positioner, and can be fitted with special jaws for special applications. Skinner says this heavy-duty chuck is sealed against dirt and abrasive materials and stands up under rugged use. **—K-16**

Flow Control Valves

Water flow control valves for high-capacity systems are now available from Dole Valve Co. For use in conserving and regulating water flow in irrigation, municipal water systems, industrial applications, and so on, these flow controls can handle capacities from 12 to 90 gpm.

A flexible rubber orifice automatically regulates the flow of water to within ±10 per cent of the prescribed gpm flow rate of each valve. Sizes from 12 to 30 gpm have 1 in. IPT at both ends. Sizes from 30 to 90 gpm have $2^1/_2$ in IPT at both ends. **—K-17**

Coil Springs

More than 800 new sizes have been added to the line of precision compression and extension coil springs available as stock items from Associated Spring Corp.

Totalling more than 1500 sizes with the added units, the springs have been designated Standard Precision Engineered Coil (SPEC) springs. They are normally available for shipment within 24 hr of receipt of order.

With a new easy-to-use SPEC spring catalog, users can rapidly match required OD, wire size, length, and other specifications with complete listings. Each spring size is listed by individual order number in sections conveniently headed by OD size.

The wide variety of stock ASC SPEC springs includes compression springs in a range of 0.057 through 0.720 in. OD, to fit standard holes, and with wire diameters of 0.006 through 0.072 in. Extension spring diameters range 0.063 through 1.0 in. and lengths range to 5 in.

The newly added compression springs include a complete range of sizes in 0.057 and 0.088 in. OD. Extension spring sizes have been added in the 0.063, 0.094, 0.180, 0.850, and 1.0 in. OD categories. **—K-18**

FOR CONSULTING ENGINEERS TURN TO PAGE 151

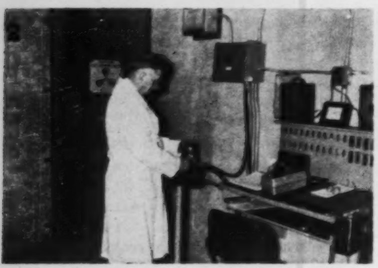
Adding new dimensions to engineering

Behind this door...

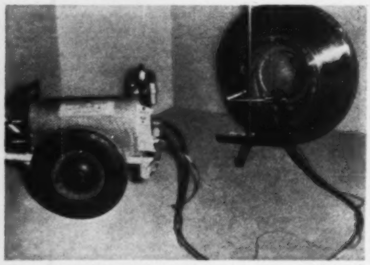
gamma- and X-rays stop centrifugal compressor problems before they start

We inspect centrifugal compressors *from the inside-out* at our new Non-Destructive Testing Laboratory. Using cobalt 60, iridium 192 or 160-KV X-ray equipment, we look all the way through centrifugal compressor parts to be certain they are free from defects. This extra care in manufacture means extra dependability in the field. It's another reason why users of Ingersoll-Rand centrifugal compressors can expect...and get...more reliable, trouble-free operation.

Controlled from a remote station...gamma rays probe deep...to provide visible internal inspection



At one of 3 test stations, an Ingersoll-Rand radiographer uses remote controls to place radioactive pellets of iridium or cobalt in the exposed position...



...within the thick concrete test cell. The gamma rays penetrate the compressor part and expose the film. The radioactive pellet is then returned to its shielded container.

The developed radiographic view is carefully inspected by I-R metallurgists to be certain that the part is free from defects. Radiography is one of many non-destructive testing methods used by Ingersoll-Rand.

THE WORLD'S MOST COMPREHENSIVE COMPRESSOR EXPERIENCE

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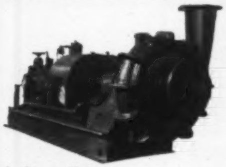
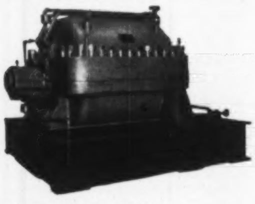
Why Ingersoll-Rand can supply EXACTLY WHAT YOU WANT in a Centrifugal Compressor

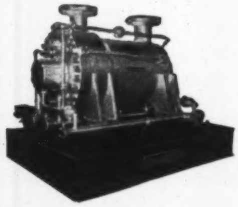
MORE TYPES AND SIZES to choose from



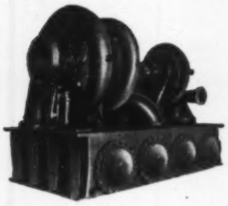
Single-Stage Units
Pressures to 1000 psi
Capacities to 700,000 cfm



Multi-Stage, Horizontally Split
Pressures to 800 psi
Capacities to 200,000 cfm



Multi-Stage, Vertically Split
Pressures to 5500 psi
Capacities to 20,000 cfm



Intercooled 100-psi Units

These four basic casing types can be combined into multiple-unit installations to meet any pressure and capacity requirement. And every design features . . .

GREATER ADAPTABILITY to meet your specific needs. Seals, cooling methods and side-load connections are just a few of the many design details that can be "tailored" to each installation. What's more, every compressor is backed by . . .

MORE THOROUGH TESTING in the world's largest and best-equipped compressor test facility. Here new centrifugal designs, components, accessories and complete machines can be tested, frequently at full load and under simulated operating conditions.

5 MILLION HORSEPOWER of I-R centrifugal compressors are serving all types of applications throughout industry.

283A12

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KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Automatic Vacuum Units

Gas cooling with a fan for forced circulation is now incorporated in automatic vacuum heat-treating units manufactured by Ipsen Industries, Inc. This feature improves metallurgical results and lowers production costs.

To operate the unit, the charge is placed in the furnace and the door is shut and sealed. The operator only has to set temperature and time to start the unit through its automatic cycle. After pumping to a preset vacuum, the work is heated. At the end of the soak cycle, an inert gas is introduced into the chamber and a centrifugal fan forces the gas along the finned cold wall and then up through the work load. The atmospheric path is controlled to direct it through the work at optimum velocity and with minimum turbulence. When work reaches 300 F an alarm sounds to inform the operator that the work can be unloaded.

An example of rapid cooling is taken from performance records of the VFC-300 vacuum furnace pictured. In this case a 302-lb work load of type 410 stainless-steel screws was cooled from 2100 to 500 F in less than 14 min. **—K-19**

Portable Strain Indicator

A portable strain indicator, providing digital readout and twice the gage-factor range previously provided, has been announced by Electronics and Instrumentation Division of Baldwin-Lima-Hamilton Corp.

Designated the Type 20, the indicator represents a significant improvement over the Type N unit and provides these features: Digital readout—eliminating interpolation from dials and meters; doubled gage-factor range—increased from the former range of 1.77 through 2.22 to a range of 1.50 through 4.50 in the new indicator.

The indicator is designed to give simple, fast, dependable operation with most commercially available strain gages in one, two or four-arm networks; and with strain-gage transducers, bonded or unbonded, to provide direct indication of the measured variable.

Weighing 18 lb, the Type 20 indicator is 13 in. wide, 8$^1/_2$ in. high and 9$^1/_2$ in. deep. It incorporates transistors and printed circuits, color-coded five-way binding posts and is enclosed in a rugged Formica case. **—K-20**

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Taylor

Flow and DP Transmitters

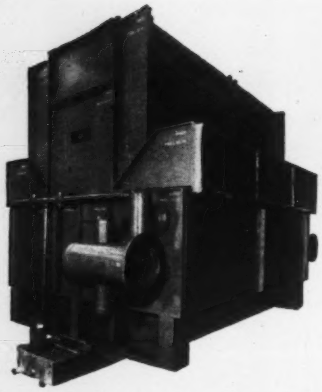
Continuing its integrated line of economical, high-accuracy, penumatic transmitters Taylor Instrument Co. ammounces its 212T Series of Transcope flow and differential-pressure transmitters.

The new instruments feature a liquid filled, diaphragm-sealed primary unit which is designed for hydraulic overrange protection to full static pressure of 1500 psi applied to either of the pressure ports. The replaceable diaphragms isolate all other primary working parts from corrosive process fluids and help contain the silicone fluid used to provide effective pulsation damping above 2 cps. Since static pressure compensation is built into the primary force beam assembly, it is not necessary to correct further for it when calibrating the instrument.

An ingenious arrangment of cantilever springs is used to extract the square root from a flow measurement. Without using any extra parts, the calibration may be adjusted to give a linear output which is proportional to the differential pressure. These procedures are made possible by utilizing a powerful servo relay to drive a rugged motion beam in the feedback assembly.

Providing a standard 3–15 psi output, these instruments are available in either an indicating or a blind form, with a transmission accuracy of $^1/_2$ per cent over a continuously adjustable range interval of 20 to 250 in. of water (differential pressure). In the indicating model, the servo operates a low-friction tape-drive motion amplifier which conveys the signal from the transmitter section to a pointer for indication on the large 11$^3/_4$-in-long circular scale. **—K-21**

HEART DISEASE
#1 Enemy
GIVE ®
Defense #1
HEART FUND



You Get EXTRA SAVINGS From This Method of Compressed Air After Cooling

Cooling water savings and power savings quickly repay the cost of the Niagara Aero® (air-cooled) After Cooler for compressed air or compressed gases. In addition its long life and the labor-saving simplicity of its maintenance give you an extra profit in comparison with water-cooled surface contact methods.

With the Niagara After Cooler the heat of compression is removed and dispersed into the atmosphere by the evaporation of a very small amount of water. The compressed air temperature is always brought below that of the atmosphere surrounding your air lines, so that no further condensation can take place.

Large users of compressed air for plant services or processes choose Niagara Aero After Coolers for their dependable durability. They have been making good records of service for over 25 years.

Write for Bulletin 130.

NIAGARA BLOWER COMPANY
Dept. ME-9, 405 Lexington Ave., New York 17, N. Y.
Niagara District Engineers in Principal Cities of U. S. and Canada
Circle No. 150 on Readers' Service Card

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Compressor Selector

Gast Manufacturing Corp. offers a slide rule by means of which, given the required air flow in cfm at 0 psig, a choice of rotary air-pump models is indicated. By setting the pointer on the opposite side of the selector then gives the motor horsepower requirements and complete air-flow characteristics over the range of 0 to 28 Hg vacuum or 0 to 30 psig pressure. **—K-22**

Hydraulic Hand Pump

A fast-acting, two-speed hydraulic hand pump which not only handles high force, high-pressure requirements up to 10,000 psi but delivers extremely high volume at low pressure (7.35 cu in. per stroke from 0 to 200 psi) to quickly move the cylinder piston to and from the work, has been announced by Owatonna Tool Co., Precision Hydraulics Div.

The new "Dualmaster," Y-29 series, automatically changes to the high-pressure stage when a load is encountered, delivering 0.294 cu-in. per stroke from 200 to 10,000 psi. Common cover plate, to which pump and valving are compactly mounted, permits the unit to be used with other than the standard OTC reservoir. A versatile mounting pad on the common cover plate accepts either a two-way valve for controlling single-acting cylinders or a four-way valve for controlling double-acting cylinders.

The Dualmaster weighs only 34 lb and measures $26^{1}/_{2}$ in. long, 8 in. wide and 12 in. high overall. Reservoir capacity is 2 gal. **—K-23**

Pilot Valves

The Oilgear Co. has announced a new line of solenoid-operated fluid-power pilot (directional) valves. All sizes have $^{3}/_{8}$-in. pipe taps and are suitable for pressures up to 3000 psi. They are direct solenoid operated with spring-returned plungers. Other features include large flow areas, equivalent to $^{3}/_{8}$-in. XH pipe size tubing, alloy iron bodies, precisely bored plunger holes accurately machined port openings, alloy-steel plungers, and multiple balance and lubricating grooves. The solenoid is totally enclosed and sealed against moisture and contaminated atmospheres. A stem in the solenoid cover permits manual valve operation for set-up and troubleshooting.

Bracket-mounted pilot valves with $^{3}/_{8}$-in. pipe-tap ports and $3^{3}/_{8}$-in. mounting bolt circle are available with both normally open and normally closed two and three-way plungers. Similar panel-mounted pilot valves with combination panel ports and pipe-tap ports are also available. **—K-24**

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For Quick Results

Iron and Steel Processes

Hydrocarbon Research, Inc., has introduced a pair of processes for use in the iron and steel industry. One produces iron from iron ore by direct reduction with hydrogen. The other is for the low-temperature separation of air to get tonnage oxygen for steel making.

Use of tonnage oxygen in steel making improves quality control and makes for faster heats. In Bessemer converters, use of oxygen results in production of steels low in nitrogen and phosphorus.

Main advantage of Hydrocarbon's "H-Iron" process for direct reduction of iron ore with hydrogen is that it eliminates the need for a blast furnace and hence for coke in new steel-mill installations. This gives steel makers greater freedom in locating their plants.

Capital cost of an H-Iron plant, according to Hydrocarbon, is about half that of a new combined coke-oven and blast-furnace installation. **—K-25**

Elevated Temperature Locknut

An elevated temperature locknut made of Waspalloy, a nickel-base alloy, is intended for use with high-performance bolting at temperatures up to 1400 F. Designated FN 1418, the one-piece selflocking nut, developed by Standard Pressed Steel Co., has properties which make it possible to utilize the full potential of high-strentgh 1200 and 1400 F. Principal applications of the new locknut are on jet and rocket engines, missiles, gas turbines, and other high-temperature power-generation equipment.

The FN1418 was designed to develop its full strength at rated temperatures of the recently introduced SPS EWB 1218 series—high capacity bolting made of Unitemp 212 for use up to 1200 F. The nut is also intended as a mate, at temperatures to 1400 F. for the SPS EWB 1615 and BE 1615 nickel-base family of bolts. The FN1418 also has limited application with these bolts up to 1600 F. **—K-26**

Booster Pumps

Long recognized for its ease of maintenance, performance, and service, the recently redesigned Roy E. Roth Co. booster pumps, design ISA, contain engineering refinements which even increase those characteristics.

The new Roth pump model ISA is designed for booster service up to 60 psig in suction, boiler feed, condensate return, transfer, or circulation. A wide choice of mechanical seals provides maintenance-free operation in locations which prevent weekly maintenance of packing. This model comes in 85 sizes with the following maximum limits: Discharge 160 psig, suction 60 psig, mechanical seal 110 psig, and temperature 210 F. **—K-27**

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Centrifugal Pumps

Two designs of double-volute, single-stage centrifugal pumps are now being produced by Pacific Pumps, Inc., Div. of Dresser Industires, Inc. Both designs incorporate an axially split case that provides for unusually easy access. Neither suction nor discharge piping need be removed, and bearings, packings, seals and the impeller can all be reached in minutes. NPSH is minimum.

Type DS is a water-cooled unit produced in 22 sizes in capacities up to 13,000 gpm with a 375-ft differentail head. It operates up to 350 F.

Type DL is an air-cooled unit produced in 13 sizes in capacities up to 6000 gpm with a 375-ft differential head. It operates up to 250 F.

For maximum parts interchangeability all 35 sizes are based on only six shaft-size groups. Various bearing types may be chosen. Parts in a liquid contact can be fabricated from any commercial metal.

Pacific Pump Bulletin 143 provides size-selection chart, design cross sections, mounting and space-occupancy dimensions.

—K–28

Gage Isolator

A gage isolator, designed to prevent gage damage from pressure surges in all types of hydraulic circuits, is being offered by Sarasota Precision Products, Inc., a subsidiary of Racine Hydraulics & Machinery, Inc.

The subplate-mounted gage isolator is a normally closed, spring-returned, three-way valve. Depressing a push button opens the pressure line to the gage to permit reading. When the button is released, the gage is isolated from pressure and drained to the reservoir. The device acts as an effective snubber to prevent gage damage caused by pulsations, chatter and fluid hammer. Accurate gages prevent damages to hydraulic components, molds, dies and the like.

Gage isolators, also available with $^1/_4$ in. NPTF ports for in-line mounting, are available for operating pressures to 5000 psi and can be used with any hydraulic oil and other noncorrosive fluids. **—K–29**

Control Valves

A series of lever or pilot-operated dual-sealing type, two way hydraulic control valves, especially suited for use in hydrostatic testing of tubing, pressure vessels and similar items, has been announced by Hunt Valve Co. in Bulletin 604.

Said to be capable of holding rated pressure in both directions, thus eliminating the need for additional external check valves, Hunt's dual-sealing valves are suitable for pressures up to 5000 psi. Valve U-packers face in toward valve ports so any intensification of pressure results in tighter sealing.

In high-pressure hydraulic service, the valve can be closed and the inlet pressure dropped, with high pressure still held on the outlet side. Also, high pressure on the outlet side can be intensified for testing, within valve pressure rating limits, without leakage or damage to the packers, the manufacturer states.

Hunt dual-sealing type two-way hydraulic control valves are offered in $^1/_2$, $^3/_4$, 1, $1^1/_4$, $1^1/_2$ and 2-in. sizes. Available pressure ranges are 2000, 3500 and 5000 psi. **—K–30**

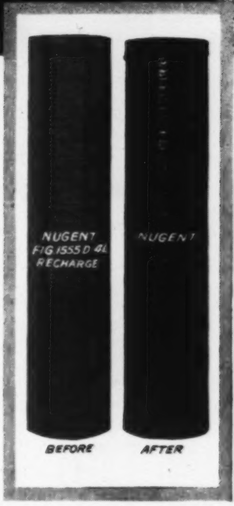

Fig. 1555D size 4L recharge and a clogged charge. Size particle retention . . . about 5 microns. Working pressure . . . 125 psi. tested at 375 psi. Maximum operating temperature . . . 375°F. Only foreign solids are removed . . . additives and dertergent oils are unaffected.

1061

Pipe Line Compressor Stations Utilize NUGENT FILTERS

Capitalizing on the extremely minute particle retaining ability of Nugent Disc Type Filters, the Houston Texas Gas and Oil Corporation Pipe Line has installed 12 lubricating oil filters along its line. Each filter protects a gas engine driven gas compressor by filtering all the lube oil every cycle. Dirt and contaminants are removed before they can harm expensive equipment.

The charge for each filter contains 12 cartridges with a total filtration surface of 37,200 sq. in. Filtering SAE 40 lube oil at about 175°, the charges average about 2000 hours, retaining over 230 lbs. of solids per filter. Greater efficiency means less servicing, less downtime and smaller recharge stocks.

For complete information on Nugent Laminated Disc Type Filters, write for Bulletin 7C. Do it today!

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3412 CLEVELAND STREET, SKOKIE, ILLINOIS

REPRESENTATIVES IN PRINCIPAL CITIES

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SIGHT FEED VALVES • FLOW INDICATORS

Circle No. 99 on Readers' Service Card

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Ball Valve Seats

New "Fire-Seal" seats for Hills-McCanna Co. ball valves provide tight shutoff of flammable or dangerous fluids in event of fire which might elevate temperatures beyond the limits of standard nonmetallic seating materials.

Construction consists of a primary seat of metal-encaged reinforced Teflon which incorporates an accurately machined secondary metallic seating surface. If the reinforced Teflon is destroyed by excessive heat, shutoff of flow is insured by the metal-to-metal contact between ball and secondary seat. **—K-31**

SYNTRON PARTS FEEDERS DO THE WORK OF MANY HANDS

Vertical Vibratory

SYNTRON PARTS FEEDERS

—speed production, increase efficiency of most operations requiring continuous controlled feeding of small parts.

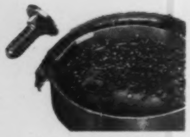
—flexible enough to handle a wide variety of parts—sizes, shapes materials.

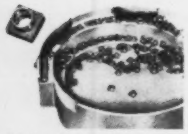
—adaptable to most automatic machines. Supply parts in an oriented, single-line at rheostat controlled rates.

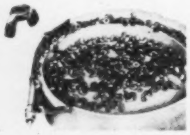
—dependable, powered by the world famous Syntron Electromagnetic drive unit, 3600 vibrations per minute, rheostat control, no mechanical wearing parts to replace or maintain.

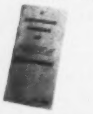
—custom built, each feeder is engineered to the specific part that is to be handled.

Investigate the possibilities of Syntron Parts Feeders in your parts handling operation.


Feeding special bolts


Feeding special brass parts


Feeding wing nuts



Write today for a Syntron Catalog and complete information about Syntron Parts Feeders.

61PF1

SYNTRON

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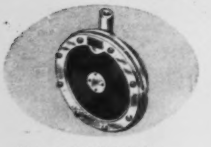
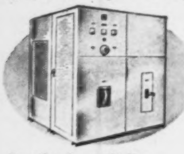
"Other Syntron equipment of proven dependable quality."


Hopper Level Switches


Rectifier Power Units

Flow Control Valves

Circle No. 123 on Readers' Service Card

Floating Gearmotors

New floating gearmotors for runout table and heavy-duty conveyer applications are now available from the Westinghouse Electric Corp. in ratings from 1 to 15 hp.

These floating gearmotors, called "Verti-Seal," feature a special seal which prevents the lubricating oil in the gear casing from leaking into the windings of the integral motor mounted below the gear unit. This results in a continuous "fail-safe" operation and saves the user countless maintenance expenses involved with conventional floating gearmotor designs.

In addition, "Verti-Seal" drives feature single-reduction worm gearing with a hollow low-speed shaft fitting over and keyed to the driven shaft. A bracket, either on the gear case or on the motor, is used to connect a spring-loaded torque arm to the table to oppose the reaction torque. This arm allows the gearmotor freedom to float on the driven shaft, thus minimizing possible roll neck eccentricity and also reduces shock caused by intermittent loadings.

These drives are said to effect up to 60 per cent savings in aisle space over regular gearmotors, because the hollow low-speed shaft permits this unit to be mounted directly on the driven shaft. **—K-32**

BUSINESS NOTES

Wellman Relocates

The Wellman Bronze and Aluminum Co. has moved its plant facilities from Cleveland, Ohio to the former Dow Metal Products Co. magnesium and aluminum casting plant in Bay City, Mich. Wellman leased the foundry from the Dow Chemical Co. in February of this year.

Wellman has been an active supplier of light metal castings for 51 years. The Bay City facilities make Wellman the largest foundry in the United States for sand and permanent-mold magnesium and aluminum castings, and will permit additional activity in these fields. Major expansion will be made in the aluminum castings area. New aluminum melting furnaces have been installed and when facilities expansion is complete, the foundry will have 25 aluminum and 6 magnesium permanent-molding units. Wellman patterns have been moved from Cleveland to Bay City without interrupting existing orders. Present products include parts for missiles, aircraft, and instrument firms as well as a wide range of commercial castings.

LATEST CATALOGS

Fasteners

A 56-page fastener handbook has been published by Southco Div., South Chester Corp. The handbook contains complete data on a wide variety of specialty fasteners; includes sizes, dimensions and installation data. Completely illustrated, the Southco Fastener Handbook No. 11 is an invaluable aid to design and product engineers. **—K-33**

Hydraulic Fittings

Industrial hydraulic fittings are the subject of Catalog No. 1–25 of AFCO Ftting Co., Div. of The United States Air Compressor Co. Illustrations, cutaway drawings, tables and technical data are included on a wide variety of steel, brass and stainless-steel fittings all of which meet JIC standards. **—K-34**

Insulations

A bulletin of Eagle-Picher Co. describes industrial and commercial insulations for high and low temperatures. PV Supertemp block, insulating cements, fireproofing cement, pipe coverings, block insulations; mineral wool blankets and felts, protective coatings and seals are some of the products included in the illustrated booklet. **—K-35**

Retaining Rings

Catalog No. 31 of Industrial Retaining Ring Co. describes its line of pre-stacked external retaining rings in sizes from 0.250 to 1.375 in. Tables and diagrams are included for general information. **—K-36**

Reset Timer

The Eagle Signal Co. Bulletin 125 Cycl-Flex Plug-In Reset Timer, describes two desirable optional features of this device which was introduced in July 1960.

Timer setting by key lock limits setting of the timer to qualified personnel only. The key itself performs the dial setting. When removed, the desired time setting is automatically "sealed in."

Pilot light (top center of dial) is normally used to give immediate visual indication from a distance, that the timer is timing. This same pilot may also be installed by the supplier as an indication that the timer is resting in either the timed out or rest position. **—K-37**

Miniature Gears

A line of miniature precision gears and gear blanks is described in a recent catalog by Northfield Precision Instrument Corp. Sizes range to $1^{1}/_{2}$ in. major diameter in stainless steel and aluminum. Bores range from 0.090 to 0.250 in. in both pin and clamp types. A simple formula is given to permit pricing of each type gear, in extra fine pitches, and up to AGMA precision class 3 gears. **—K-38**

At CUMMINS ENGINE COMPANY'S New Test Building ··· water pump systems run safely and silently

Figure 636 Globe-Type Silent Check Valve installed at Cummins' Test Building. Available for 3" to 24" lines.

Eighteen Williams-Hager Silent Check Valves are installed on boiler feedwater, condensate and vacuum pump lines, as well as dynamometer and engine cooling water pump systems, in the new Engine Test Building at Columbus, Indiana. These check valves operate the instant flow reversal starts, eliminating pressure surges and resulting water hammer before they are created. Result: assured silence and safety of liquid systems.

Write for Bulletins: No. 654 on Valves; No. 851 on Cause, Effect and Control of Water Hammer; No. 659 on Pressure Loss Tests.

WILLIAMS • HAGER
Silent
Check Valves

The WILLIAMS GAUGE CO., Inc.
149 Stanwix Street
2 Gateway Center • Pittsburgh 22, Pa.
Our 75th Year • 1886-1961

Circle No. 137 on Readers' Service Card

Semiconductor Cooling

A 12-page handbook issued by Delta-T Semi-Conductor Cooling Div., Wakefield Engrg., Inc. thoroughly covers semiconductor cooling in theory and practice. Explains temperature, power, and airflow measurement techniques and rating procedures. **—K-39**

Press Equipment

H-P-M Div., Koehring Co. in Bulletin 6000 describes press equipment for pressure processing. Information is given regarding metalworking presses, custom hydraulic presses, C-frame presses, plastic molding machinery, die-casting machines, and also hydraulic pumps, valves, cylinders, and power units. Illustrations and general specifications are included. **—K-40**

Heating Equipment

An eight-page bulletin of Dunham-Bush, Inc. shows steam and warm water heating equipment. This illustrated brochur includes cutaway drawings, and capacity tables for easy reference. **—K-41**

Butterfly Valves

The Henry Pratt Co. has published Bulletin 6 which describes completely new designs in rubber seat butterfly valves. The bulletin covers models from 3 to 144 in. and for pressures from vacuum to 150 psi. It also contains tables of dimensions. **—K-42**

Electric Motors

This 12-page catalog was designed by Fairbanks, Morse & Co. to assist motor users, resellers and specifiers in the selection of suitable motors from $^{1}/_{2}$ to 10,000 hp for specific installation on original equipment, in commercial buildings, and industrial installations. Outlined are a-c induction motors, either low- or high-slip for normal or troublesome loads. A number of mechanical variations are shown in this catalog, because mounting, ventilation and ambient conditions play an important role in motor selection. Also included is a section on constant speed, unity power factor Synchronous motors, in horizontal or vertical construction. **—K-43**

Spring Components

Intended to assist both the design engineer and the buyer of spring components, a comprehensive spring handbook has been published by The Timms Spring Company.

Fully illustrated with a wide range of samples from actual Timms production, the new brochure discusses the features of precision springs of every possible type, from simple compression, extension and torsion springs to Belleville, wave and finger-type washers. Four-slide parts (both round and flat-wire forms) and nonferrous specialies are also covered.

Design formulas are explained in detail, and other reference material valuable in determining the user's spring needs is presented in graph and table form. **—K-44**

WIPE OUT

Maintenance Costs!

Specify THOMAS FLEXIBLE COUPLINGS

Troublesome maintenance and lubricating problems are eliminated when you specify Thomas "All-Metal" Flexible Couplings to protect your equipment and extend the life of your machines.

Like a thief in the night an inadequate coupling causes wear and damage to your machines — resulting in high maintenance costs and costly shut-downs.

UNDER LOAD and MISALIGNMENT *only* THOMAS FLEXIBLE COUPLINGS *offer all these advantages:*

- Torsional Rigidity
- Free End Float
- Smooth Continuous Drive with Constant Rotational Velocity
- Visual Inspection While in Operation
- Original Balance for Life
- Unaffected by High or Low Temperatures

NO MAINTENANCE
NO LUBRICATION
NO WEARING PARTS
NO BACKLASH

Write for Our New Engineering Catalog 60

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

Circle No. 125 on Readers' Service Card

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Hydraulic Installation

Catalog 21 covering requirements for a complete hydraulics installation, from pumps to accessories, has been issued by Oil-Dyne, Inc.

Ninety-six basic models of the miniaturized hydraulic pump are fully described and illustrated. Other products cataloged are hand pumps, standard and heavy-duty pressure switches, relief valves, gages and a full line of cylinders, from $1/2$ to 4 in. bore sizes.

A section of the catalog is devoted to accessories recommended for use with Oil-Dyne equipment and includes tube and pipe fittings, hose, couplings, filters, strainers, a wide range of various types of valves, heat exchangers, timers, accumulators and electrical accessories. **—K–45**

Centralizer Lubrication

Catalog 82, illustrating and describing its line of centralized lubrication equipment, has been published by Lincoln Engineering Co. Division of The McNeil Machine & Engineering Co.

Featured in the 32-page catalog is Lincoln's complete line of lubricant application equipment with descriptions of fully automatic, semi-automatic and manual methods of operation.

High and low-pressure lubricant injectors, timing and alarm controls and filler pumps are described along with several pages of installation accessories such as tees, hose, flexible feed lines, coupling studs, and so on. **—K–46**

Dust Arresters

Northern Blower Div., Buell Engineering Co. offers a new eight-page brochure covering automatic bag-type dust arresters that collect dust without interruption during bag cleaning. The booklet gives design and assembly information; tells how the dust collector operates; diagrams construction details; and tabularizes dimensions and capacities.

Text explains how air passes through the cloth filter bags and depositis dust on the inside surfaces, and how a varaible-speed electric timer controls tye cyclic shaking and cleaning of bags. Construction details are given in such items as housing, bottom plates, bag-holder frames, and bags. Specification tables itemize engineering data for arresters in 25 capacity ranges, and include number and size of bag compartments, number of bags, cfm ratios, and approximate weight of arresters and supporting steelwork.

Also included are information and photographs regarding pneumatic and electric operation, rotary discharge valves, continuous screw conveyers, bag bands, and exhaust fans. **—K–47**

Belt-Conveyer Rolls

A bulletin describing its Series 156 line of medium-duty ball-bearing belt conveyer rolls is announced by Webster Mfg., Inc.

Both troughing and return idlers are presented in the bulletin, which lists dimensions and weights for 4 and 5-in. trough and return idlers for belts ranging from 18 to 36 in. wide. Webster states that this line of idlers was developed for general purpose belt-conveyer installations for materials-handling duty widely required in industry. All roller assemblies are of equal length and interchangeable for quick replacement and minimum standby stocks. Rolls are made of heavy gage tubular steel with cast ends. Ball bearings are double sealed and require no lubrication after leaving the factory. **—K–48**

Centrifugal Fans

Bulletin GP-100, with full details on a line of cast-housed centrifugal fans, is available from General Blower Co.

The compact design of the small-volume fan is excellent for use in exhausting fumes from chemical laboratories, handling light dust from polishing wheels and grinders, or for any exhaust purpose where low volumes are encountered.

This line has cast, radial-bladed wheels, dynamically balanced and mounted directly on the motor shafts. The bulletin lists four sizes with nine capacities suitable for a complete range of small-volume pressure requirements. An optional feature is a cast aluminum wheel. Also optional are explosion-proof, drip-proof, water-proof or totally enclosed motors in place of the standard open motor. **—K–49**

Precision Differentials

A four-page folder containing detailed specifications and engineering information on precision differentials and end gears, is available from Instru-Lec Corp.

Keyed drawings and tables are included for solid and hollow-shaft differentials, in wide and narrow design. Clearance circles for twelve solid-shaft differentials covered by the folder range from $1/2$ to $1\,13/16$ in. Length of shaft extension, distance between end gears, shaft diameter, maximum width, bevel gear OD, end gear-face width, end gear-mounting diameter, and diametral pitch are included for all listed units.

Similar information is provided for six different hollow-shaft differentials, in wide and narrow versions. In addition, specifications cover backlash, break-away torque, construction materials, and end gear mounting.

Four tables list data on precision end gears for 96, 72, 64, and 48 diametral pitch, respectively. Each table covers 28 units and the number of teeth varies over a range from 24 to 192. **—K–50**

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Aftercooler

An 8-page bulletin which describes "Paracoil" Type AC aftercoolers, for compressed air and gas applications, has been released by Davis Engineering Div. of Tube Reducing Corp.

The release, identified as Bulletin 120, covers the operating features and design characteristics which the full range of Paracoil units provides for industrial air service. A floating tube-sheet end, which incorporates weep holes in the retaining ring to forestall mixing of shell and tube-side fluids, is described in detail.

Capacities of stock models of Paracoil aftercoolers range from 30 to 5650 standard cfm of air (at 68 F, 14.7 psia and relative humidity of 36 per cent). A table of sizes and capacities, and associated moisture separators, is included. Special designs are available for capacities in excess of catalog ratings. **—K–51**

Hydraulic Control Pilot

A two-page catalog sheet from Atlas Valve Co. gives detailed information on Atlas No. 811 hydraulic control pilot, designed for extremely accurate control of diaphragm valves. This spring-loaded, diaphragm-actuated pilot operates on city water supply or on light oil. It combines the fast response of a relay with the stability of te wide proportional-band controller. It is extremely accurate, responding to variations of as little as 1 psi in the flow line to readjust the main regulator for precise throttling of the steam, gas or liquid flow. Desired settings are easily adjusted. Controlled pressure ranges are 3–15 psi, 10–40 psi. A minimum actuating pressure (water or oil) of 30 psi is required.

The catalog sheet also includes special features of the pilot, its applications and opertion together with diagrams and table of arrangements. **—K–52**

Steel Bars

La Salle Steel Co. has introduced the second in a series of case study portfolios on "Fatigue-Proof" steel bars.

The latest portfolio deals with the effect of "Fatigue-Proof" on end costs in typical parts applications. It shows cost savings in individual studies on: An adapter for a coil-winding machine; a diesel pump fitting; a foundry-flask guide pin; an oil-pump distributor shaft; a power-steering pedestal shaft; a motorcycle axle shaft; a generator armature shaft; a transmission shifter post; an outboard motor tilt pin; and a ball stud for a steering arm.

In addition to an illustration of each part other pertinent information includes the dimensions of the part, its use, the AISI grade and hardness of the steel replaced, plus the operations eliminated. **—K–53**

Laminated Plastics

Techniques for machining laminated plastics are described in a brochure issued by Synthane Corp. manufacturer and fabricator of laminates for industrial, electronic and electrical applications. The brochure provides general machining information and describes specific techniques. Illustrated design hints for laminates are also shown.

Machining operations described include circular sawing, band sawing, turning and boring, threading, automatic screw machining drilling, milling, gear cutting, punching and machining of hard-grade laminates.

Recommendations on tools to be used, speeds, feeds, cooling and lubrication, and other important details on machining practices are given for each operation. Eleven different hints for designing with laminated plastics, each with a detailed drawing, are presented in the brochure. **—K–54**

Flexible Metal Hose

Data to help the engineer select the right flexible metal hose and design it into each specific installation are available in a Catalog 600, an illustrated guide containing 32 pages produced by Atlantic Metal Hose Co.

Included is information on how to rate hose working pressures so that corrections can be made for job conditions. Among the problems considered are nonsteady pressures, elevated temperatures and the fitting attachment to use with each hose style. Much of this information is given in tabular form.

Atlantic's guide details how to determine correct hose length and how to install and use hose so as to insure maximum service life. It also describes standard Atlantic assemblies, their construction, materials used, fittings, features, applications and the common media for each. **—K–55**

Pumps

Bulletin 124-G of Chicago Pump introduces its complete line of vertical, enclosed-shaft, non-clog VCS pumps.

These pumps are designed for sewage, sump or storm water service in institutional, industrial, municipal and commercial applications with capacities from 50 to 5000 gpm and heads to 105 ft.

The bulletin has been planned for the busy design and layout engineer, as it systematically and in sufficient detail describes a simple method for determining non-clog pump head and capacities. Followed in logical order are easy to use pump and motor-selection tables; preliminary layout dimension data on the pumps, basins and basin covers; engineer specifications; illustrated details of the necessary controlling devices, optional equipment and installations. **—K–56**

"MAKES ONE BEARING OUTLIVE TWO"
say Leading Textile Manufacturers

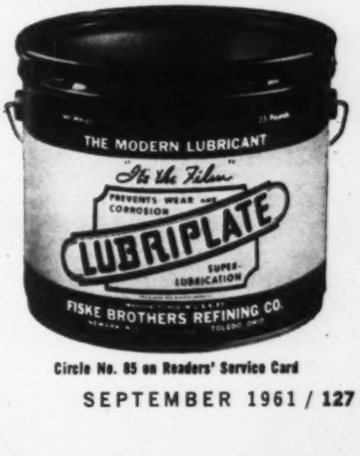
LUBRIPLATE Lubricants actually condition bearing surfaces and stop progressive wear. They prevent rust and corrosion and resist steam, hot water and many acids. They meet all conditions of the Textile Industry. Use LUBRIPLATE and make One Bearing Outlive Two.

REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE GREASE AND FLUID TYPE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE COSTS.

LUBRIPLATE is available in grease and fluid densities for every purpose . . . LUBRIPLATE H. D. S. MOTOR OIL meets today's exacting requirements for gasoline and diesel engines.

LUBRIPLATE
H.D.S.
Motor Oil

For nearest LUBRIPLATE distributor see Classified Telephone Directory. Send for free "LUBRIPLATE DATA BOOK" . . . a valuable treatise on lubrication. Write LUBRIPLATE DIVISION, Fiske Brothers Refining Co., Newark 5, N. J. or Toledo 5, Ohio.



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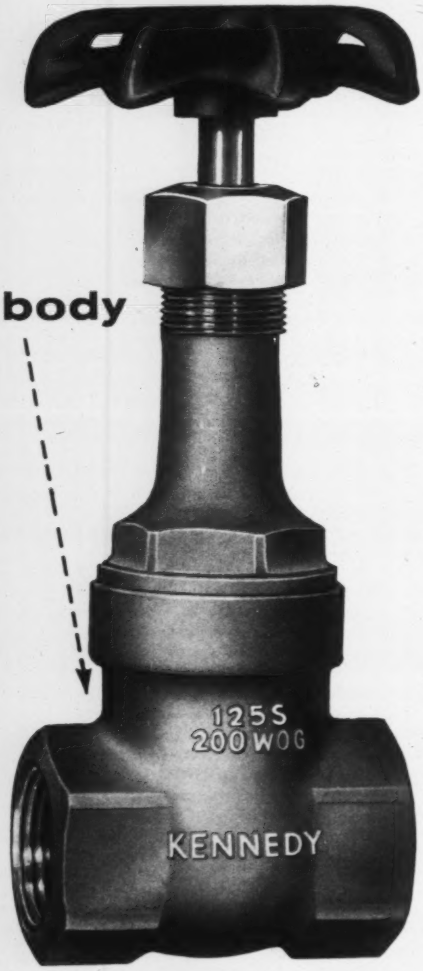

Here's *WHY* KENNEDY VALVES give you *more* valve for your money...

Fig. 425
125 lb. S.W.P.
BRONZE GATE VALVE...
- **Rising stem**
Inside screw
Wedge Disc

Cylindrical body

This construction withstands sudden pressure, resists rupture and minimizes deflection under severe conditions. Wider hex ends, blended into body, prevent distortion during heavy wrench pressure. In this Kennedy design, body and hexes blend into one unit, no thin body wrists extending to pipe ends.

Fig. 425 conforms to Federal Specification WW-V-54, Type II, Class A. These valves can be repacked under pressure, thus eliminating line shut-downs. Simply open valve fully, remove packing nut and repack.

Available in sizes ⅜" through 3".

Find out how these valves can give you better, longer service. Get the complete story in Bulletin 613.

Write today.

125 S
200 WOG
KENNEDY

Fig. 425

These additional KENNEDY features help give long, trouble-free service:
KENALLOY® Stem
Pistol-Grip Handwheel

KENNEDY VALVE MFG. CO.
ELMIRA, NEW YORK
VALVES • PIPE FITTINGS • FIRE HYDRANTS
• OFFICES AND WAREHOUSES IN NEW YORK CHICAGO SEATTLE SAN FRANCISCO ATLANTA • SALES REPRESENTATIVES IN PRINCIPAL CITIES •
DUCTILE IRON VALVES • CAST IRON VALVES • BRONZE VALVES • INDICATOR POSTS • FIRE HYDRANTS

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KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Steel Design and Engineering

Four papers which discuss continuing advances in the strength levels, product forms and design applications of constructional steels are printed in a 59-page brochure, "New Concepts in Steel Design and Engineering," offered by United States Steel Corp.

In sum, the papers describe and compare the types of steels that make up the modern "family" of constructional steels. Illustrations and descriptions of many actual designs and design concepts show how these steels can be used in structures and equipment to achieve higher strength, lighter weight and lower costs. **—K-57**

Drafting Pen

Ozalid Div., General Aniline & Film Corp., has recently made available a complete cataloging of accessories and prices for its revolutionary "Grafika" drafting pen. The Grafika, which uses a capillary principle for control of ink flow, will draw 1000 ft of line, in widths from hairline to $^3/_{16}$-in. on a single filling.

In additon to its large capacity in conventional pen size, the Grafika, with only 11 nibs and a freehand attachment, will perform any drafting, lettering, or freehand task. It can be adjusted precisely to match any previously-drawn line and will not show a "joint" when line work is interrupted and finished some time later.

The Grafika may be used with any type ink, water color, or wash, and will write on any type drafting material—paper, cloth, film or even glass. It is adaptable to any lettering guide or template. **—K-58**

Flow-Rate Controllers

The Brooks Instrument Co., describes a new line of flow-rate controllers for purge and other flow control and indication applications in Bulletin 148.

Designated as Series 8800, the instruments are completely self-contained. A single unit includes the rotameter mounted on a needle-valve-operated flow controller. The controller has an internal diaphragm assembly designed to give a constant pressure differential for any valve setting. Because of the unit construction, all external piping has been eliminated.

Series 8800 rotameter controllers are available in several sizes ranging in flow capacities from 0.01 gph (water) or 0.2 scfh (air) to 12 gpm or 48 scfm. Pressure rating depends on materials of construction; 250 psig for brass models; 500 psig for 316 stainless-steel modes. (These materials are standard; others are available.) Diaphragms can be furnished in any of several material combinations, to permit user selection for optimim performance under particular temperature and corrosive conditions. **—K-59**

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NEW YORK, N. Y.

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KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Roller Bearing

A recirculating roller bearing claimed to have the lowest and most uniform friction characteristics available has been announced by The Kaydon Engineering Corp. in Data Sheet S-133 and Bulletin S-132.

The Recirc-L-Way bearing has a coefficient of friction as low as 0.00025 under a 500-lb load and 0.25 ipm linear motion. With this load and speed, the bearing has only one eighth of the coefficient of friction compared to other bearings of this type.

Ultraprecision matched sets may be obtained with a total height variation within ±0.000010 in.

New design concepts of the Recirc-L-Way bearing include the use of a recirculating cage with positive roller guidance between lipped raceways. The cage also maintains uniform spacing of rollers, eliminating rubbing friction; ends erratic performance, particularly at low speeds, caused by sliding skewing, and binding of the rollers; and pulls unloaded rollers around the bearing raceway.

These bearings are designed for high-capacity applications for vertical or horizontal linear reciprocating motion of machine elements or slides of precision machine tools. Net weight is 22 oz for a bearing $1^{1}/_{4}$ in. high by $1^{11}/_{16}$ in. wide by $3^{1}/_{2}$ in. long. **—K-60**

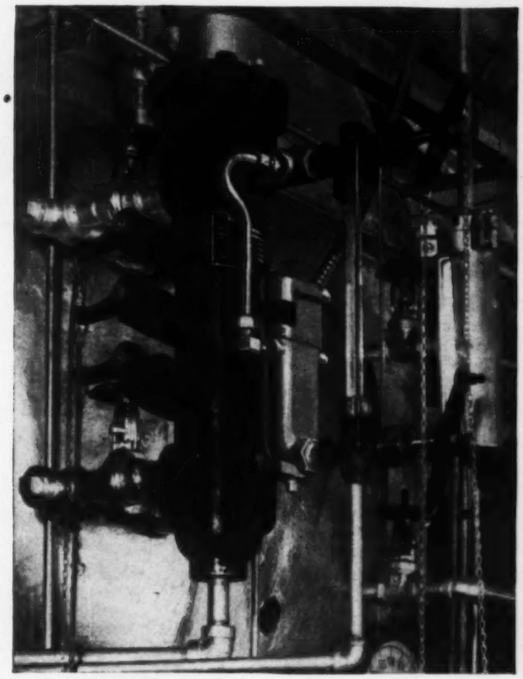
Rotary Pumps

Specification sheet 100 b by Blackmer Pump Co. describes a series of motor-mounted rotary pumps for handling clean liquids and solvents (up to 5000 SSU). These versatile pumps offer economy and ease of installation on jobs requiring delivery rates from 10 to 30 gpm at pressures up to 125 psi. In this compact design the pump and motor are built as an integral unit with a common heavy duty shaft supported by the motor bearings. Each pump is equipped with a built-in relief valve to bypass delivery in case of excessive pressure. **—K-61**

Steel Pulleys

Bulletin 1160 describes one-piece steel "Curve Crown" pulleys, featuring exclusive spun-end construction recently developed by Stephens-Adamson Mfg. Co. All end-plate weldments have been eliminated in the fabrication of the new spun-end pulleys, according to the company engineers. Thus, principal sources of metal fatigue, stress, and other trouble have been eliminated. The result is a pulley which inherently is much stronger than previous types. The new pulleys are available up to 24 in. in diameter.

The brochure also describes the "Squeeze Lock" hub which exerts equal locking forces in two directions, to both the shaft and pulley end plates. Other sections of the eight-page brochure include a Curve Crown pulley-load rating chart, dimensions and weights for Curve Crown pulleys, and charts which show a comparison of belt training effects for various types of pulleys. **—K-62**



Low Cost Protection

that helps you to avoid water level accidents

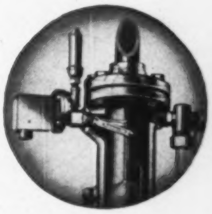
What Reliance Levalarms can do for you:

1. operate alarms — low or high water level.
2. actuate fuel cut-out — single or dual.
3. control pumps — start and stop.

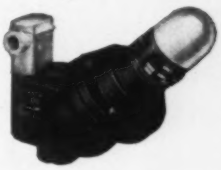
Both low and high liquid levels in boilers and various tanks and vessels need "watch-dog" service, as you know. Reliance Levalarms help maintain control by *signalling* dangerous conditions or by actually *motivating* fuel cut-outs, pumps, etc.

Illustration above shows Levalarm EA-15R on a water column. It can serve as fuel cut-out, or cut-out and alarm. Under the cap on top of the column are terminals of electrodes that extend into the column. They form a Levalarm capable of handling a combination of duties such as listed above.

Other members of the valuable "Levalarm Family" are shown at right. Ask for more complete information on these versatile devices that insure positive, economical warnings and control.



EA-7, float-actuated switch; low and high alarm.



EA-100P, float and electrodes; single or dual fuel cut-out.

EA-101, electrode; alarms, fuel cut-out or pump control.

The Reliance Gauge Column Company
5902 Carnegie Avenue • Cleveland 3, Ohio

Reliance®

BOILER SAFETY DEVICES

Circle No. 111 on Readers' Service Card

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Torches

A data sheet of Arcair Co. describes several Arcair torch models and related equipment designed to cut, gouge, bevel, and remove all metals.

The Arcair torch uses air from an ordinary 80-psi air line, current from a d-c welding machine, and special Arcair copperclad electrodes to melt and remove metal. The torch can be operated in any position, and the air jet is always aligned with the point of the arc automatically, regardless of position. **—K–63**

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G-A *CUSHIONED* SOLENOID OPERATED VALVE

Where remote control valve operation is desired, specify and use the G-A Cushioned Solenoid Operated Valve that automatically opens or closes on any type of electrical impulse. The operating sequence—whether on open or closed circuit—can be made to suit your requirements. Sizes 2″ to 36″

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Designers and Manufacturers of VALVES FOR AUTOMATION

Circle No. 62 on Readers' Service Card

Flexible Ball Joints

A 4-page catalog on flexible ball joints for handling liquid oxygen, liquid methane and other cold-temperature liquids and exotic fuels, has been published by the Aircraft Div. of Barco Manufacturing Co.

Catalog No. 233-B includes specifying information on the new "Featherweight" series of stainless-steel or steel flexible ball joints which are built specifically to meet newest missile and space program safety requirements in handling liquid oxygen and liquid methane or helium, as well as other cryogenic fluids or gases. They also have desirable features for handling fluid or gaseous chemicals or petrochemicals and liquefied petroleum gases and hydrocarbons at temperatures from −325 to +275 F.

The catalog includes information on Type FL stainless-steel flexible ball joints which are especially designed for installation in metal fuel lines on ballistics-missile launchers and ground-support equipment. **—K–64**

Weight Sensing

A reference manual of Exact Weight Scale Co. describes the application of automatic weight-sensing.

The purpose of this manual is to show how a principle of weight sensing or measurement of force can be utilized to perform a wide variety of control functions. This proven principle of automatic control is based on the use of the one-to-one (1:1) ratio predetermined weight scale and automatic electrical readout, a development of the company.

The flexibility and dependability of the exact weight principle make it adaptable for incorporation into almost any type of machine where precise control is a part of the function. Exact weight controls are being used in machines for packaging of foods and chemicals, metalworking, textiles; equipment for cost and quality control; and weight feeders for plastics injection molding. **—K–65**

Storage Water Heaters

Bulletin No. 1234, issued by The Patterson-Kelley Co. describes a line of storage water heaters.

The eight-page bulletin lists storage and heating capacities, dimensions, and material thicknesses for vertical and horizontal water heaters of plain steel, copper silicon, copper lined, and Pre-Krete lined.

A separate section provides information on P-K's new Scalefree 230 indirect gas-fired storage water heater, a completely packaged unit with storage capacities ranging from 250 to 4000 gal and recovery capacities from 390,000 to 2,215,000 Btu. Also included is a separate listing of other available catalog data on P-K heaters. **—K–66**

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Liquid Loaders

A 28-page liquid loader catalog is now available from OPW-Jordan. Liquid Loaders are widely used in the chemical and other processing industries to load or unload bulk fluids—anything that will flow through a pipe—principally with tank cars or tank trucks. The catalog describes and illustrates fully the seven basic types of liquid loaders available: Slide sleeve, long range, scissors arm with valve inboard, scissors arm with valve outboard, single arm, utility, or bottom loading. The three types of balancing systems available include compression spring, torsion spring, or counterweight. It also shows what type liquid loader to use and where, suggestions for better performance, loading valves available, swivel joints and miscellaneous fittings, flow charts, capacities, dimensions, prices and complete engineering and technical information. **—K-67**

Instruments and Controls

A four-page, Bulletin, G14-1, describing the complete line of Bailey instruments and controls is available from Bailey Meter Co.

The new bulletin illustrates and describes fluid meters for recording, indicating and integrating; transmitters and recorders for pressure and draft; level transmitters; and temperature instruments.

Also illustrated and described are plug-in components, the Bailey Flamon detector, analysis instruments, and Bailey 700 analog and digital systems. Literature for each of the components and systems is listed. **—K-68**

Soot Blowers

The air-driven Vulcan T-30 Mark I-A long retractable soot blower is described in Bulletin 1073 released by Blaw-Knox Co., Copes-Vulcan Div.

This eight-page bulletin has fifteen drawings showing exclusive design features in addition to photographs illustrating the complete unit from several angles. The effective cleaning pattern made possible by dual-motor drive and multihelix jet paths is explained by diagrams. **—K-69**

Package Boilers

A 16-page catalog, No. SB63 with full color cutaway views shows, step by step, the design and construction of the Keystone 2-drum watertube package boiler for oil or gas firing.

Erie City Iron Works pioneered the arrangement in a packaged boiler of an upper and lower drum symmetrically connected by banks of watertubes. The complete boiler unit is always in even balance for easy handling to the job site or for easy removal to another location. Fold-out pages reveal all details at a glance. Complete data are included for capacities from 5000 to 1,000,000 of steam per hr. **—K-70**

Shell-Type Motors

Bulletin 107, featuring a complete line of shell-type motors, has been released by Louis Allis Co.

Available in open, enclosed or liquid-cooled ratings ranging from $^{1}/_{2}$ to 150 hp, the shell-type motor is a built-in machine drive that features accuracy and close tolerance to facilitate ease of assembly and correct fit with machine components.

Features of the shell-type motor include compact design and lightweight construction; also small motor diameter allowing closer spacing of spindles and maximum flexibility with four to nine different horsepower ratings available in a single diameter. **—K-71**

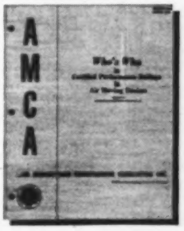
Who's Who

The first edition of "Who's Who in Certified Performance Ratings" is now available to users and specifiers of air moving equipment. This new publication of the Air Moving and Conditioning Association meets the recognized need for an official directory of manufacturers and products licensed by AMCA to use the Certified Ratings Seal.

in Certified

The 54-page directory contains essential product identification data on all air moving devices which have been tested and rated for performance in accordance with the rigid requirements of the AMCA Certified Ratings Program. Revised issues will be published periodically.

Copies of Bulletin 261A, "Who's Who in Certified Performance Ratings" are available from: Air Moving and Conditioning Association, Inc., 2159 Guardian Building, Detroit 26, Michigan.



Ratings?

Circle No. 174 on Readers' Service Card

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Metal Products

The wide variety of products of Ohio Knife Co. are used in many industries such as machinery, metalworking, iron and steel, pulp and paper, woodworking, and so on. A comprehensive catalog has been issued by the company in which separate sections are devoted to detailed descriptions of cutters, tools, and equipment parts used by each of the foregoing industries. **—K–72**

Aluminum Joining

Bulletin 23 of Handy & Harman describes Handy Alumibraze, an alloy form and method for joining aluminum. It has been tested several years in production by a major fabricator of aluminum parts. The manufacturer states that the following advantages have been determined: Strong, sound joints; corrosion resistant; rapid replacement of alloy; minimum amount of alloy needed; alloy stays put while hearing; elimination of preform problems; and reduced tool and fixture costs. **—K–73**

Flexible Couplings

Pump and compressor coupling applications are described in Bulletin 141 of Thomas Flexible Coupling Co.

Advantages listed by the company for under load and misalignment flexible couplings include: Torsional rigidity, free end float, smooth continuous drive with constant rotational velocity, visual inspection while in operation, original balance for life, and unaffected by high or low temperatures. **—K–74**

Scales

Bulletin 8003 of Fairbanks, Morse & Co. shows how self-container warehouse scales can meet special requirements in factories, foundries, paper mills, shipping and receiving rooms, and freight and baggage rooms. Flexibility is achieved through these choices: Cabinet dials (four) or pillar dials (six); five sizes of platforms; metal box or skeleton-frame construction. The same choice of frames and platforms is provided with the standard double-beam units. **—K–75**

Multiple-Element Switches

Bulletin 604 of Synchro-Start Products, Inc. describes four, five or six-element speed-sensitive switches, which use the same proven principles and construction as its two-switch and three-switch governors "combined." This permits the use of each operating point of the three-switch governor to operate two adjustable swtiches instead of one, affording a maximum of six adjustable switching elements instead of three. Each switch has independent normally open and normally closed contacts rated for 10 amp at 115 volts alternating current and is adjustable within its range.

The maximum range of each switch is determined by dividing the normal speed of the governor shaft in maximum RPM by the number of switches contained in the governor selected. Normal speed can be as high as 7000 rpm. Low-speed setting can be as low as 200 rpm if the top speed is below 2500 rpm. Any number of switches can be adjusted to operate simultaneously. **—K–76**

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Circle No. 6 on Readers' Service Card

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These two big features of Lenape STUDDING OUTLETS mean better pressure vessel design, and greater economy. Curved to vessel contour, they are easily attached without supplemental reinforcement. Their low silhouette also makes them ideal for close-clearance connections.

Available in all ASA Standard sizes and pressures.

See pages 36-41 of Lenape General Catalog for full details and specifications. Write for your copy.

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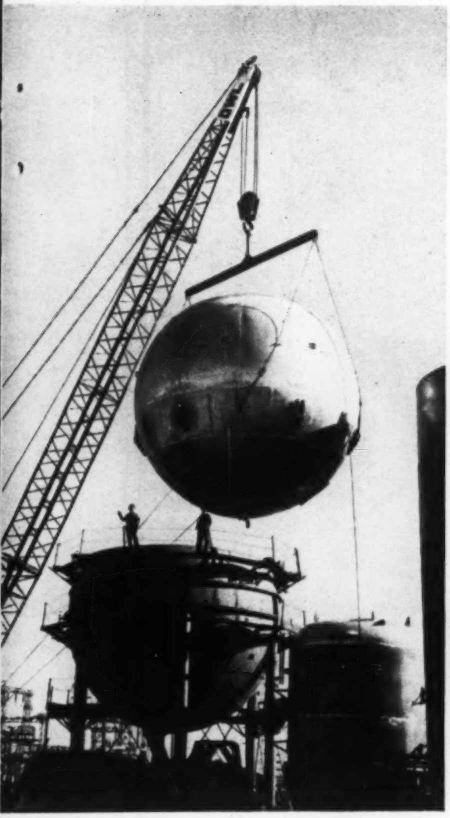
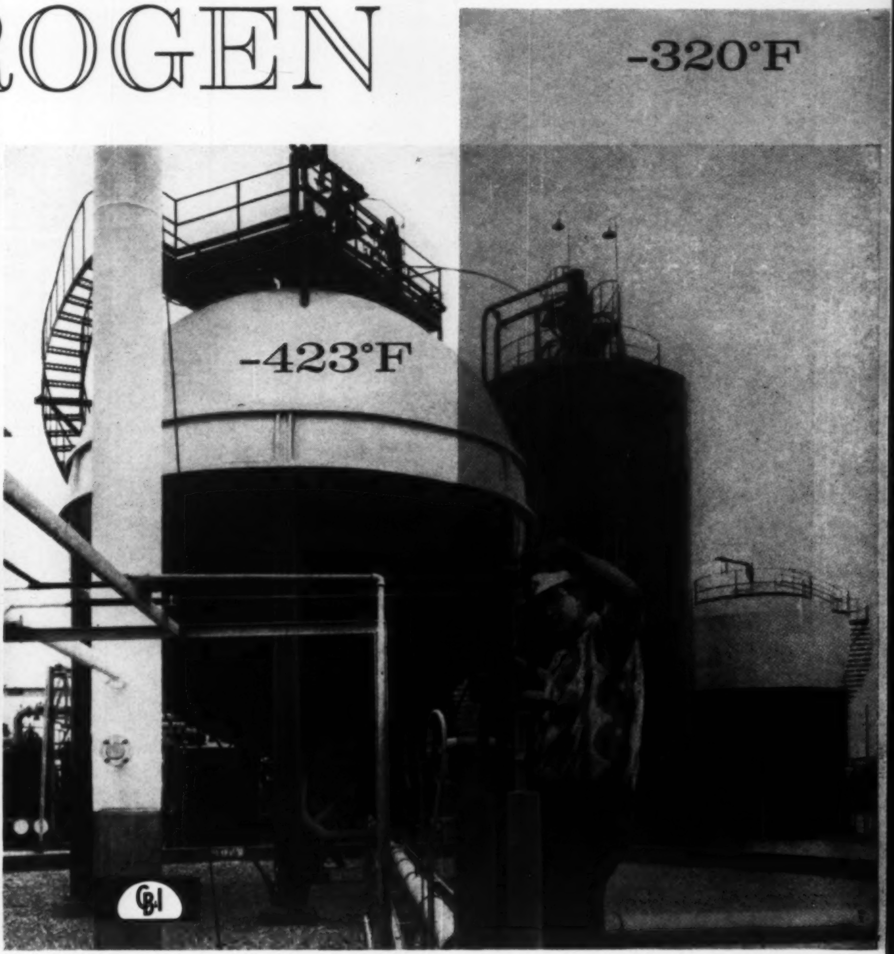
DEPT. 114, WEST CHESTER, PENNSYLVANIA

Circle No. 83 on Readers' Service Card

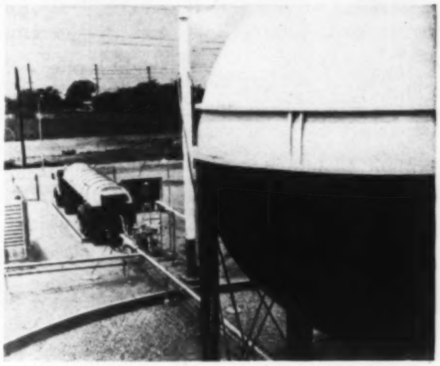
First privately owned and operated space-age plant furnishes liquid hydrogen to missile centers and industrial users

NITROGEN HYDROGEN





These double-wall cryogenic storage tanks play a vital role in the first privately-owned plant to supply liquid hydrogen on a large-scale commercial basis. Hydrogen is stored in the sphere at −423°F and nitrogen in the cylindrical tank at −320°F. Located in Torrance, Calif. and owned by Linde Company, Division of Union Carbide Corporation, the plant will deliver 3,300,000 lbs. of liquid hydrogen yearly to missile centers. Both tanks were designed (using Linde-approved designs), fabricated and erected by CB&I, world's most experienced builder of cryogenic vessels.



ABOVE: Aluminum inner shells and carbon steel outer shells were used for the two cryogenic tanks. The spherical tank is 28 ft. in diameter and the cylindrical tank 21½ ft. Special insulation is between the shells.

TOP LEFT: The inner sphere is suspended in the outer sphere by stainless steel rods positioned around the perimeter. Resting on the ground nearby is the aluminum inner shell of the cylindrical nitrogen tank.

LEFT: A trailer is being loaded with liquid hydrogen for delivery to missile centers, other government installations, or industry.

CB&I

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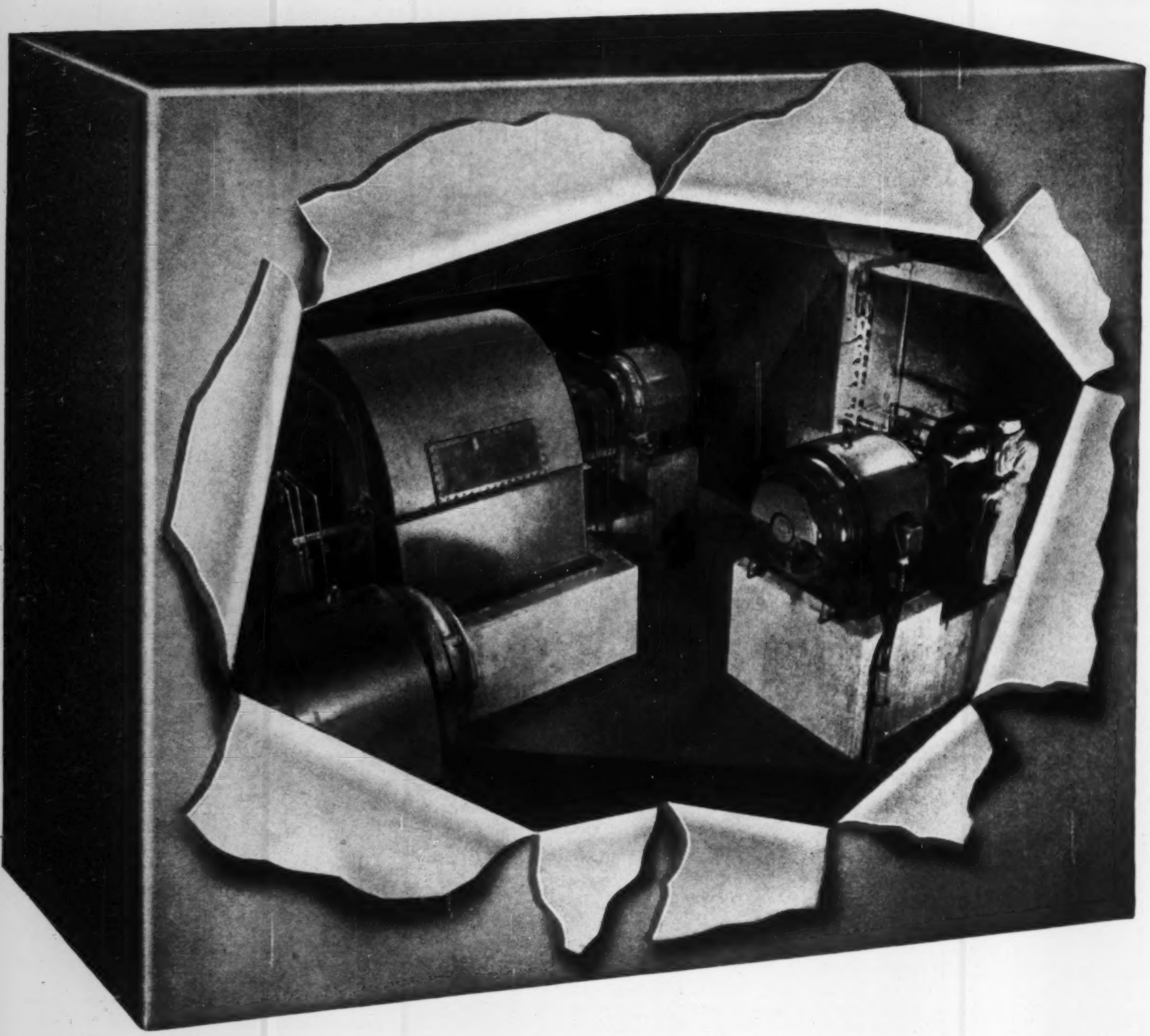
Circle No. 34 on Readers' Service Card



More power to ALTON BOX BOARD

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Mechanical draft is among several assignments of Clarage equipment at Alton Box Board Co., Alton, Illinois.

On the left above in the power plant, a Clarage Type W, Class III double inlet fan equipped with Vortex Control provides forced draft ... on the right is one of the two Clarage Type RT double inlet fans furnishing induced draft.

Investigate the advantages dependable Clarage equipment offers for YOUR mechanical draft installation. Contact our nearest sales engineering office or write us for complete literature.

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Circle No. 35 on Readers' Service Card

Model Equation
1.30
.02
.55
.0009
.31

Want to find the coefficients? It's easy with the new Regression Analysis program for the IBM 1620

Here's another program offered free-of-charge to users of the IBM 1620 Data Processing System. It gives you the kind of results you might expect only from a much more expensive computer. But users of the 1620 know that its low rental cost is deceptive. The 1620 packs *more computing power per cubic inch* than any other computer in its size range.

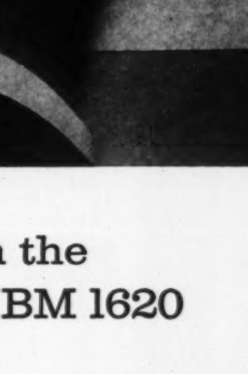
The Regression Analysis program is a good example. Suppose you want a fit for production purposes. If you employ more than two variables you probably have difficulty visualizing the representation of your data. If linearity is not the case, you must often guess blindly at a polynomial of high degree, accept or reject the fit with something approaching a sixth sense, and either try again or settle for the results you have.

The new Regression Analysis program lets you handle expressions containing up to *24 variables.* If you have the even more complicated task of handling many dependent variables, the program will generate regression coefficients with a maximum number of dependent variables not exceeding one-half the number of independent variables.

This program will also fit non-linear functions and hyper-surfaces. Compare this performance with that of any other computer in the 1620's price range.

A basic 1620 installation rents for just $1600 per month. For details, contact your local IBM Representative.

Circle No. 78 on Readers' Service Card



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Publications of The American Society of Mechanical Engineers

FLUID METERS, THEIR THEORY AND APPLICATION Provides authentic, reliable information on fluid meters and metering techniques. Section A, defines the terms used to designate thirty-eight types of fluid meters, describes some of the special methods useful in tests which involve fluid flow and its measurement, lists the symbols employed in fluid metering, defines the special terms used in connection with fluid meters, and discusses the methods of measuring the quantities to which they are applied. Section B, considers some of the distinctive features of fluid meters, presents the theory of fluid measurement, and describes in full the development of practical working equations from theoretical relations. Section C, gives the figures and tables useful in solving practical fluid measurement problems along with examples to illustrate the proper use of the data presented. **1959 $8.00**

FLOW MEASUREMENT Offers the best available information on the construction and installation of the three most extensively used differential head metering units, namely, thin plate orifice, flow nozzle and venturi tube. After outlining the advantages and disadvantages of these units, the report takes up their construction, recommends types of pressure connections to use, illustrates location of pressure taps used with orifices and flow nozzles, shows the general arrangement to be used when a flow nozzle is mounted in plenum chamber, discusses the system by which differential pressure can be measured and presents the values of flow coefficients in tabular form. The report also shows how the primary elements are installed, includes examples to illustrate the appropriate methods of applying data, and gives tolerances for discharge coefficients, flow coefficients, and the expansion factors.
PTC 19.5.4 **1959 $5.00**

FATIGUE OF METALS ***Being the Proceedings of the 1956 Conference sponsored by IMechE-ASME*** Comprises an invaluable collection of information on the basic aspects of fatigue stress distribution, temperature frequency and environment, metallurgical aspects, and engineering and industrial significance of fatigue. **Contents:** Basic Studies. Stress Concentration, Combined Stress Tests, Effect of Mean Stress. Cumulative Damage, Statistical Aspect, Repeated Stream Cycling, Effect of Frequency. Effects of Temperature, Metallurgical pects, Light Alloys, Corrosion. Engineering and Industrial Significance of Fatigue in Automobiles, Aircraft Engines, Marine Machinery, Railroad Equipment, Welded Construction, and Aircraft Structures. **$15.00**

PROCEEDINGS, 1957 CONFERENCE ON LUBRICATION AND WEAR In this volume current lubrication knowledge is evaluated and the findings of important experiments conducted in the United States, Canada, United Kingdom and Europe, presented and discussed. Topics covered in the 104 papers of the volume include hydrodynamic lubrication, boundary friction, boundary lubrication, bearing metals, novel bearing materials, glands and seals, solid lubricants, surface treatments, ball and roller bearings, gear lubrication, engine lubrication, miscellaneous lubricants and applications, additives, and wear. The conference was arranged by the IMechE with the collaboration of the ASME. **$23.00**

THE ROLE OF VISCOSITY IN LUBRICATION Factors affecting viscosity, the sensitivity of machines to viscosity change, and the criteria used in selecting viscosity of oils for machine parts, are some of the aspects of the subject covered. **Contents:** Effect of Temperature on Viscosity. Effect of Pressure on Viscosity. Effect of Rate of Shear on Viscosity. The Sensitivity of Equipment to Variation in Lubricant Viscosity. Sensitivity of Machines to Lubricant Viscosity. Lubrication of Roll Neck Bearings and Gear Drives in Continuous Rolling Mills. Effect of Viscosity on Hydraulic Systems. Viscosity and Related Problems in Engine Design. Selecting Lubricant Viscosity for Design of Helical and Worm Gears. Viscosity in the Lubrication Mechanisms of Rolling-Element Bearings. Gear Lubrication and Viscosity. Recent Research and Development Work in Rolling Bearings. The Effect of Temperature and Pressure on Viscosity as Related to Hydrodynamic Lubrication. **1960 $4.50**

VISCOSITY OF LUBRICANTS UNDER PRESSURE This is a review of experimental investigations made on 148 lubricants. Data are coordinated by means of sixty tables in which the results originally appearing in diversified units are compared. The methods proposed for correlating viscosity-pressure characteristics of oils with properties determined at atmospheric pressures are reviewed and illustrated. Experimental work on heavily loaded bearings, lubrication calculations, and additional techniques for viscosity are covered. **1954 $3.00**

SMALL PLANT MANAGEMENT In this revised second edition the basic material in the original book, published in 1950, has been updated to provide the small business man with the kind of good sound information he needs to obtain maximum utilization of his management skills. **Contents:** Part 1—The Economic and Industrial Importance of Small Plants. Small Plant Financing and Banking. Community Progress Created by Small Plants. Government Interest in Small Plants. Part 2—Top-Management Planning for the Small Plant. Organizing the Small Plant. Operating the Small Plant. Supervising and Controlling the Small Plant. Part 3—How to Fulfill the Legal Requirements. How to Get Best Workers and Labor Relations. How to Get Along with the Union. How to Buy Best Facilities and Materials. How to Obtain Best Productivity. How to do Technical Research. How to Get Best Sales. How to Do and Use Accounting. How to Pay and Save in Taxes. How to Make Savings and Use Profits. Part 4—The General Outlook for Small Plants in the United States. Quality Control in the Small Business. A Management Check List. Bibliography. Index. **1960 $10.50**

FIFTY YEARS PROGRESS IN MANAGEMENT, 1910–1960 This is both a chronical of a half century's progress in management and a portent of things to come. It comprises five ten-year progress reports. That for the period 1950–1960 focuses attention on progress made in formulating a testable philosophy of management; management as a profession; practices in general and operational management; management science, management education, and management internationally. Earlier reports extend back to the 1910–20 decade when the modern themes of management came into prominence. They accurately reflect the thinking and progress in such areas as administrative organization, job evaluation and standardization, wage plan, profit sharing, industrial hazards, occupational diseases, human factor, budgetry control, industrial marking and many other management activities. **1960 $10.50**

MATERIALS HANDLING HANDBOOK Here has been condensed and organized virtually the entire literature of modern materials handling, stressing the economies and short-cuts of the greatest importance to industry; and giving the actual operating experiences of hundreds of companies in all segments of manufacturing and industry. **Contents:** Definition and Scope. Analyzing Materials Handling Problems. Materials Handling Factors. Factory Planning. Materials Positioning in Production. Materials Handling Research. Materials Handling and Production Control. Communication Systems. Training Personnel. Handling Bulk Materials. In-Process Handling of Bulk Materials. Unit Handling of Various Shapes. Unit Handling in Manufacturing. Scrap Classification and Handling. Uses of Containers in Industry. Industrial Packaging. Palletization. Warehousing and Yard Handling. Truck Terminal Handling. Air Terminal Handling. Belt Conveyors. Elevating Conveyors. Chain Conveyors. Trolley Conveyors. Cable Conveyors. Haulage Conveyors. Vibrating and Oscillating Conveyors. Pneumatic Conveyors. Package Conveyors. Portable Conveyors. Fixed Cranes, Derricks, and Cableways. Traveling Cranes and Towers. Portable Cranes. Elevators. Winches. Auxiliary Crane Equipment. Positioning Equipment. Powered Industrial Trucks. Industrial Hand Trucks. Industrial Tractors. Highway Trucks and Truck-Trailers. Railroad Freight Cars. Marine Carriers. Air Carriers. Pallets and Containers. **1958 $20.00**

FLOW VISUALIZATION The articles in this book describe many different techniques for making fluid flow phenomena visual to the human eye. **Contents:** Importance and Use of Flow Visualization Methods. Flow Visualization in Two and Three Dimensional Flow Fields By Use of Smoke Filaments. Injection of Dye for Flow Visualization. Neutral Density Beads for Flow Visualization. Flow Visualization Using Tufts in Turbomachinery. Use of Wall Trace Techniques to Indicate Flow Pattern. Electrochemical Technique of Flow Visualization. Spark Discharge Methods for Indicating Flow Profiles. Streaming Birefringence as a Qualitative and Quantitative Flow Visualization Tool. Extensions and Limitations of Schlieren and Shadowgraph Methods. Use of Shclieren Methods to Observe Moving Waves in Reactive Gases. Application of Interferometry to Time-Varying Flow Conditions. Techniques of Flow Visualization Applicable in Low Density Fields. Specialized Applications of Electronic Flash in High-Speed Photography. Observation of Unsteady Flow in Liquid Propellant Rocket Engines. Photographic Methods of Observing Cavitation. **1960 $3.00**

COMPRESSOR STALL, SURGE AND SYSTEM RESPONSE Phenomenology prediction and control of compressor stall are the topics covered in this book. **Contents:** Instability and Surge in Dual Entry Centrifugal Compressors. Use of Experimentally Determined Acoustic Impedance in Anlaysis of Propulsion System Stability. Sonic Control of Dynamic Compressor Instability. Stall Control. Parallel Operation of Tubo-Compressor in a Common System. The Surge Problem as Related to the ASME Compressor Test Code PTC 10–1949. Effect of Induced Vorticity in the Vaneless Diffuser on Performance of a Centrifugal Compressor. Generalized Multistage Compressor Characteristics. Tip Clearance Effects on Stalling Pressure Rise in Axial Flow Compressors. Some Aspects of Stall Flutter and Compressor Blade Vibration. **1960 $2.50**

POWER REACTORS This Second Edition includes foreign as well as domestic nuclear reactors for producing electric power. For each plant the following information is given on a standardized form: Plant location; reactor type; status; estimated plant costs; electric power data, nuclear data; information on the fuel elements; also on the reactor from core overall dimensions to moderator, reflector, shielding, refueling, core heat flux, etc.; reactor control; the primary and secondary coolant systems; and the steam system. Schematic diagrams show heat removal and utilization cycle. **1959 $3.75**

RESEARCH AND TEST REACTORS The 93 facilities in this book are located in various parts of the world. For each reactor the following information is presented, also on a standardized form: Reactor location, cost of reactor facilities, operating design power, principal use of reactor, the applicable fuel, nuclear data, the reactor, and the primary coolant. **1959 $7.50**

GLOSSARY OF TERMS IN NUCLEAR SCIENCE AND TECHNOLOGY This first standard dictionary provides a common language among engineers, physicists, chemists, biologists, medical men, and others working with the atom. In its pages will be found the definitions of 1500 terms used in the nuclear field along with tables, charts, and formulae considered useful.
American Standard N1.1—1957 **$5.00**

THERMODYNAMIC AND TRANSPORT PROPERTIES OF GASES, LIQUIDS AND SOLIDS The forty-two papers in this book survey the present theoretical and experimental state of the science; indicate the gaps of knowledge existing in both transport and thermodynamic properties, particularly at high temperatures and a high or even moderate pressures; report a large amount of new data; discuss new and improved experimental and theoretical techniques; and review and evaluate the present state of knowledge in the specific area covered. **Contents:** Theoretical Estimation of Transport Properties, Review of Recent Work on Transport Properties, Thermodynamic Properties: Gases and Liquids. PVT Data and Equation of State. Thermodynamic Properties of Boron Compounds. Transport Properties: Experimental. High Temperature Transport Properties of Metals and Ceramics. High Temperature Thermodynamic Properties of Gases. **1959 $12.50**

United Engineering Center, 345 E. 47th Street, New York 17, N. Y.

MECHANICAL IMPEDANCE METHODS FOR MECHANICAL VIBRATIONS Shows how impedance methods apply to lumped and continuous systems of simple and moderate complexity, reviews measurement techniques, demonstrates the power of digital computers by comparing the calculated and measured characteristics of a highly symmetrical system of moderate complexity, gives measured values of typical structures of large size and high complexity, discusses the importance of the impedance in influencing shock and vibration spectra measured in field service, indicates how to apply impedance methods to the calculation of vibration isolator effectiveness, treats impedance of some disordered systems, shows how impedance methods may be used to find the response to ramdon excitation, and describes a dynamic stiffness method that has proven useful in predicting critical speeds of steam turbines. **1958 $5.50**

SHOCK AND STRUCTURAL RESPONSE Present specific, useful information on shock and structural response and the method of analysis and testing used. The discussion covers the nature and origin of shock loading with examples from several fields; the techniques and instruments used for shock measurement and the manner in which data are presented for engineering applications; the responses of single-degree-of-freedom systems to shock and various ways of presenting information for design application and for indicating requirements for shock-testing machines to simulate conditions occurring in actual service; the modal method of analysis for determining response cf complicated systems to shock pulses, and the applications of methods discussed in the book to some of the problems of missile bases designed to withstand ground shock produced by detonations. **1960 $4.50**

SHOCK AND VIBRATION INSTRUMENTATION Provides a fund of useful information on advances and new concepts in the technology of shock and vibration. Among the subjects discussed are random vibration, effect of nonrigid structures on vibration isolation, hysteresis and slip damping, vibration and shock testing, design approaches and analog methods. **Contents:** Evaluation of Mounts Isolating Nonrigid Machines from Nonrigid Foundations. Experimental Study of the Effects of Foundation Resilience on Vibration Isolating. Effect of Material and Slip Damping on Resonance Behavior. Shock and Vibration Environments. Mechanical Design for Random Vibration and Shock. Influence of Electrical and Motional Impedance on the Control and Performance of Some Vibration Machines. Shock Testing Machines and Procedures. Damaging Potential of Shock and Vibration. High Speed Computing Methods for Shock and Vibration Problems. **1956 $5.00**

PROCEEDINGS, 1955 JOINT CONFERENCE ON COMBUSTION Presents, in 464 pages, the complete proceedings of a IMechE-ASME sponsored conference. Subjects dealt with include combustion in boilers, industrial furnaces, diesel and dual fuel engines, and gas turbines; the scientific principles of combustion and their application; combustion research; the present state of knowledge of chemical kinetics relating to combustion; and how the chemical processes interact with physical processes. The discussions of over one hundred designers and manufacturers of combustion equipment are also included. **1955 $12.50**

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TECHNICAL DATA ON FUEL In this Sixth Edition texts and tables have been reset, the subject matter has been rearranged, the contents of the book extensively revised, tables have been recalculated where necessary, or replaced on the basis of more recent data, and a number of new topics added. **Contents:** Atomic Weights, Mathematical Tables, Units and Conversion Factors. Selected Principles and Methods of Technical Calculations, including fluid flow, fluidized flow, heat transfer, calculation of flame temperature, I-t diagram, combustion with oxygen and oxygen-enriched air. Techniques of Measurement and Special Conversion Tables, including temperature measurement, flow measurement, barometer corrections, viscometry, calorimetry. Selected Properties of Substances, including viscosity, saturated air and gas, thermodynamic properties of steam, refrigerants and heat- transfer media, thermal conductivity, specific heat, thermodynamic functions. Metals and Alloys. Refractory Materials. Gaseous, Liquid, Solid, and Nuclear Fuels. **1961 $8.75 to ASME Members and nonmembers**

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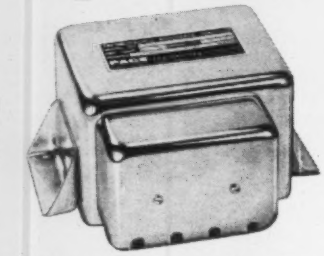

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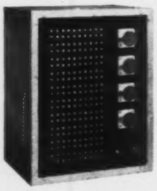

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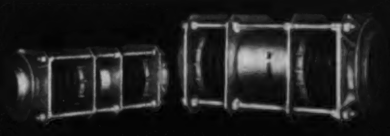

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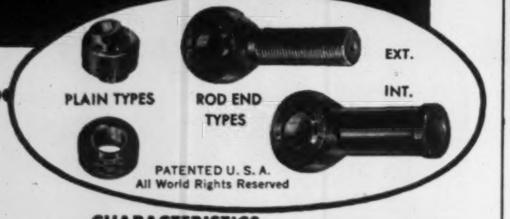

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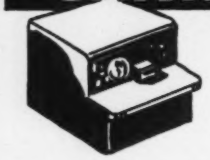

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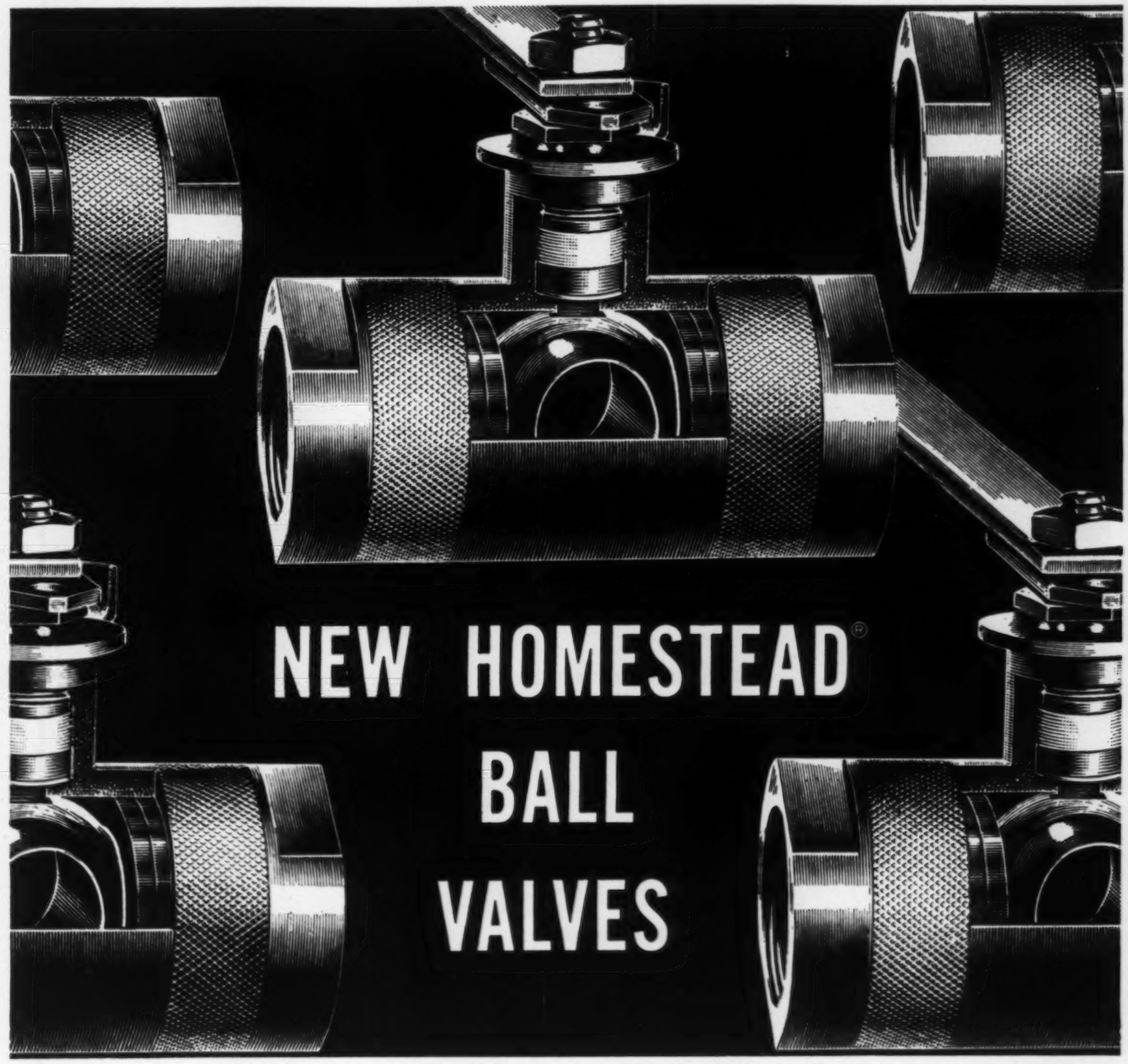

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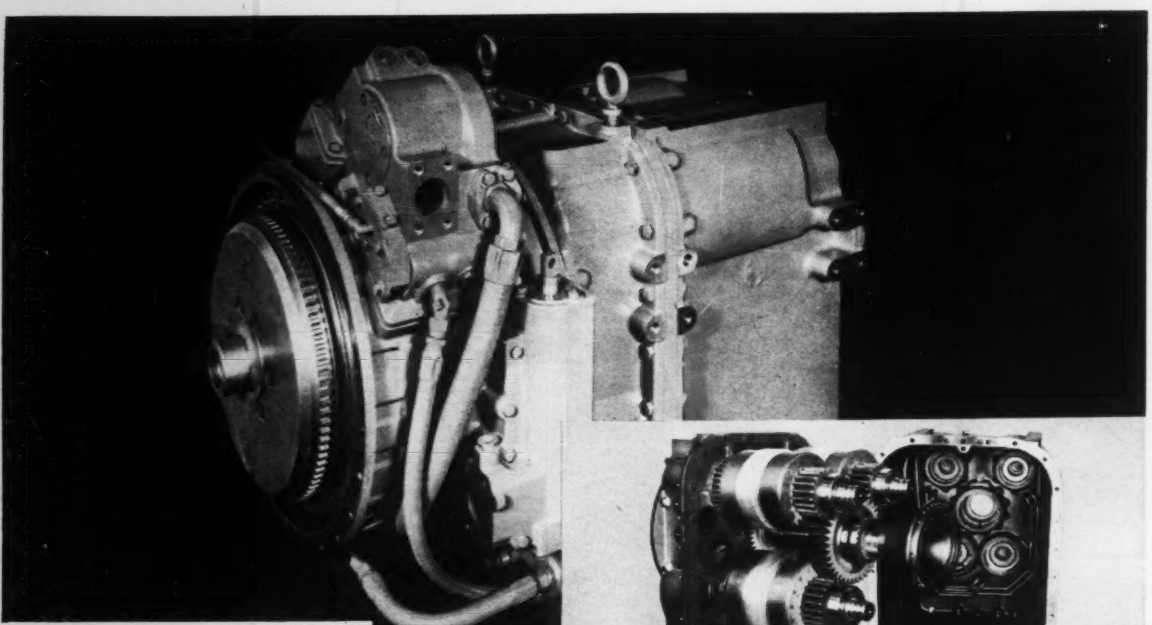

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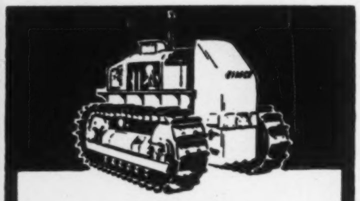

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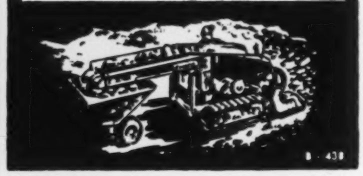

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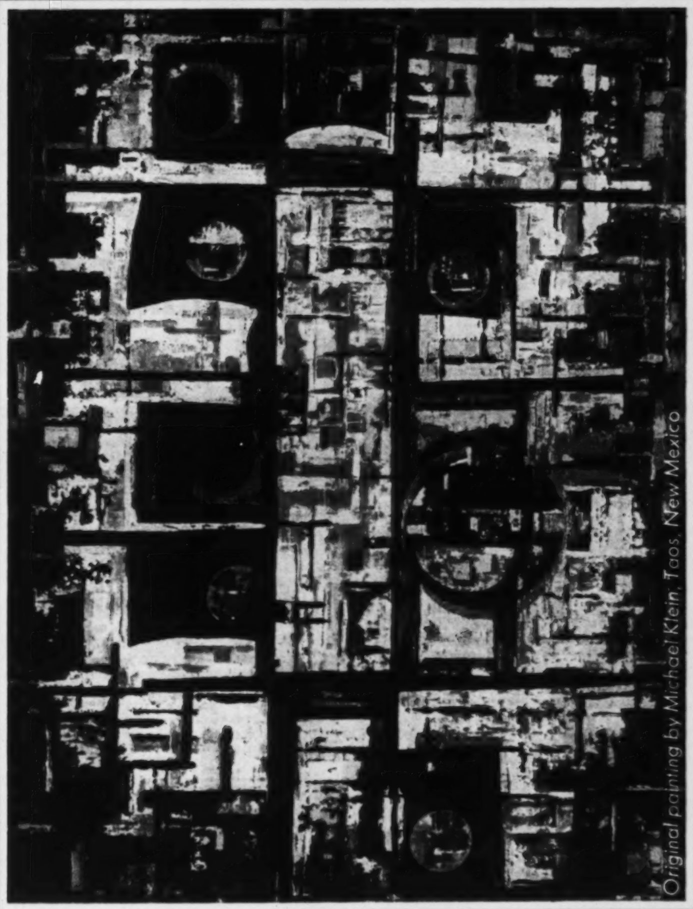

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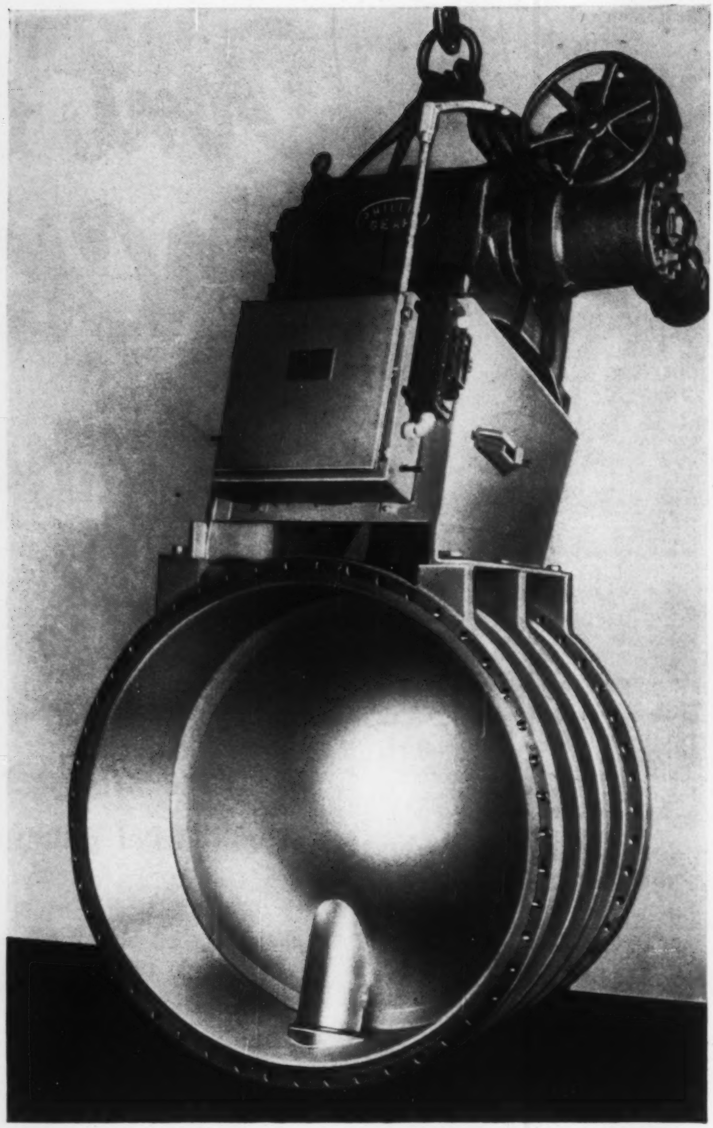

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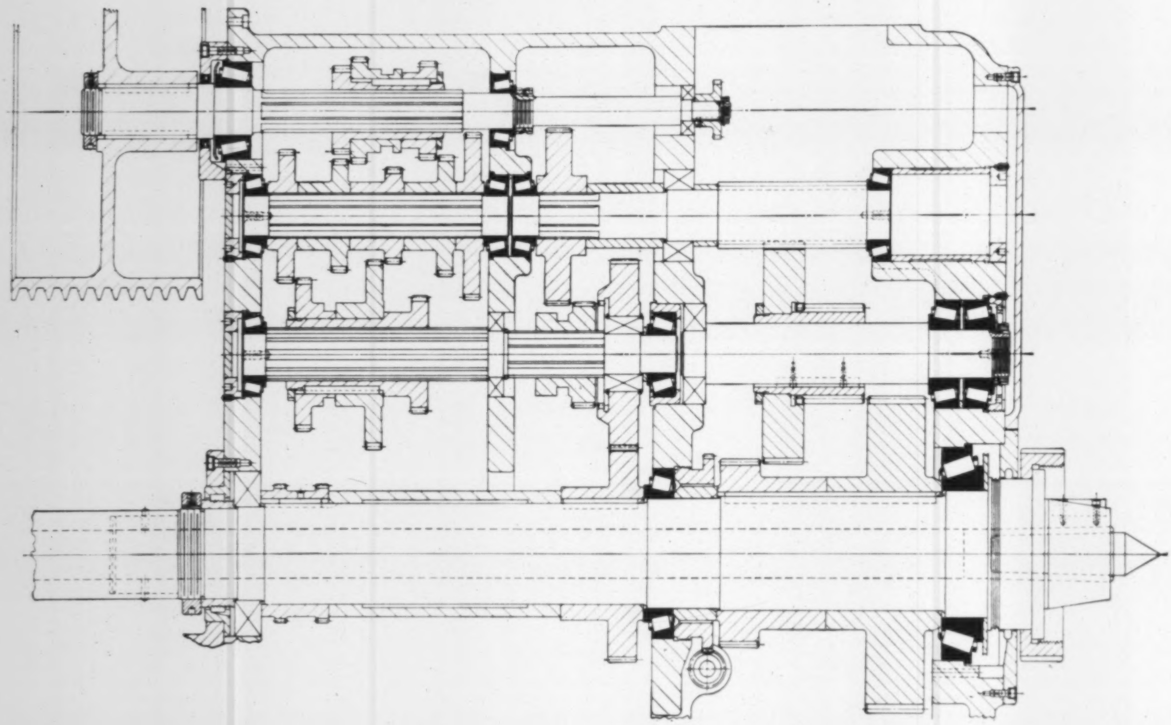

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